STI SAFETY, TECHNOLOGY & INNOVATION

OMRON

Safety Laser Scanner
OS32C Series

User's Manual

OSTI P/N 99863-0010 Rev.A
Manual No. Z296-E1-01

Original instructions

Introduction

Thank you for purchasing the OS32C Safety Laser Scanner (herein after referred to as the "OS32C").
This is the instruction Manual describing the use of the OS32C.
Always take into account the following points when using the OS32C:

Make sure OS32C is handled by a "Responsible Person" who is well aware of and familiar with the machine to be installed.
The term "Responsible Person" used in this Instruction Manual means the person qualified, authorized and responsible to secure "safety" in each process of the design, installation, operation, maintenance services and disposition of the machine.
It is assumed that the OS32C will be used properly according to the installation environment, performance and function of the machine.
A responsible Person should conduct a risk assessment of the machine and determine the suitability of this product before installation.
Read this Manual thoroughly and understand its contents.

Legislation and Standards

1. Application of an OS32C sensor by itself cannot receive the type approval provided by Article 44-2 of the Labor Safety and Health Law of Japan. It is necessary to apply it as a system. Therefore, when using this product in Japan as a "safety system for presses and shearing machines" as prescribed in Article 42 of the Labor Safety and Health Law, the complete system must receive the type approval.

2. (1) This product is electro-sensitive protective equipment (ESPE) in accordance with European Union (EU) Machinery Directive Index Annex IV, B, Safety Components, Item 1.

(2) This product complies with the following legislation and standards:

1) EU legislation

-Machinery Directive 98/37/EC, 2006/42/EC

-EMC Directive 2004/108/EC

2) European standards EN61496-1:2004 (Type3 ESPE),
EN61496-3:2001 (Type3 AOPDDR)
EN61508 (SIL-2)

3) International standards IEC61496-1:2004 (Type3 ESPE),
IEC61496-3:2008 (Type3 AOPDDR)
IEC61508 (SIL-2)
ISO13849-1:2006

4) North American Standards: per UL File E241445, US and C-UL approvals (CNN: NIPM/NIPM7).

- ANSI/UL 508 (Industrial Control Equipment)
- IEC 61496-1 (Type 3 ESPE)
- IEC 61496-3 (Type 3 AOPDDR)
- UL 1998 (Software in Programmable Components)
- IEC 61508 (Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems)
- IEC 61508-3 (Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 3: Software Requirements)
- CAN/CSA-C22.2 No. 14 (Industrial Control Equipment)
- CAN/CSA-C22.2 No. 0.8 (Safety Functions Incorporating Electronic Technology)

5) JIS standards JIS B 9704-1:2006, JIS B 9704-3:2004 (Type3 ESPE)

(3) This product received the following approvals from TÜV Rheinland of the EU.

-EC Type-Examination in accordance with the EU Machinery Directive, Type 3 ESPE (IEC61496-1), Type 3 AOPDDR (IEC61496-3)

-TÜV Rheinland type approval, Type 3 ESPE (IEC61496-1), Type 3 AOPDDR (IEC61496-3)

READ AND UNDERSTAND THIS DOCUMENT

Please read and understand this document before using the products. Please consult your OMRON STI representative if you have any questions or comments.

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The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.
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PERFORMANCE DATA

The performance data in this document is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON STI's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON STI Warranty and Limitations of Liability.

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON STI representative at any time to confirm actual specifications of purchased products.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

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The information in this document has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, proof-reading, or omission errors.

PROGRAMMABLE PRODUCTS

OMRON STI shall not be responsible for the user's programming of a programmable product, or any consequence there of.

PATENTS

Elements of the electronics and optics essential to meet the specifications and performance standards of Omron STI controls are covered by one or more of the following U.S. Patents Numbers: 6,665,621; 6,753,776; 6,493,653; 6,587,811. Additional patents pending.

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Safety Precautions

The Alert symbols and their meanings ensure safe use of the products

In order to use the OS32C safely, the precautions listed in this manual are indicated by alert symbols. The descriptions must be followed, failure to follow all precautions and alerts may result in an unsafe installation or operation.

The following indictions and symbols are used.

⚠ **WARNING**	Indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, or may result in serious injury or death. Additionally there may be significant property damage.
⚠ **CAUTION**	Indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, or there may be property damage.

Meanings of Alert Symbols

	Indicates prohibited actions.

Alert Statements in this Manual

⚠ WARNING

An OS32C is an electro-sensitive protective equipment designed to guard personnel working around hazardous machinery.

Whether a specific machine application and the OS32C system installation complies with safety regulations depends on the proper application, installation, maintenance and operation of the OS32C system. These items are the responsibility of the purchaser, installer and user.

User

⚠ WARNING

The administrator is responsible for the selection and training of personnel to properly install, operate, and maintain the machine and its safeguarding systems.

An OS32C system should only be installed, verified and maintained by a qualified person. A qualifed person is defined as *"an individual who understands, is trained on, and demonstrates competence with the construction, operation or maintenance of the machinery and the hazards involved."* (ANSI/PMMI B155.1-2006)

The machine requirements

⚠ WARNING

The guarded machine must be able to stop anywhere in its cycle. Do not use an OS32C on a press with a full-revolution clutch.

The guarded machine must have a consistent stopping time and adequate control mechanisms.

All safety-related machine control elements must be designed so that an alarm in the control logic or failure of the control circuit does not lead to a failure to danger.

Do not use the auxiliary output or warning output for safety applications. A human body may not be detected even if a failure of OS32C occurrs, resulting in serious injuries.

Installation

⚠ WARNING

The main unit must be securely mounted and its cable connectors must be tightly attached.

A start switch to release interlock must be installed where an operator can observe the monitored/guarded zone as a whole and cannot operate the switch within the hazardous zone.

A protective mechanism must be installed to prevent a hazardous condition in the event of a subsequent machine component failure. The OS32C does not protect against ejected flying material.

Severe smoke and particulate matter may degrade the efficiency of an OS32C, causing it to unexpectedly enter a Machine Stop state.

Use of mirrors or mirror-like objects in the protection plane must be avoided, as they can hide part of the area to be monitored/guarded.

Additional guarding may be required to prohibit access to dangerous areas not covered by the OS32C system.

Perform the test procedure in this document at installation, after maintenance, adjustment, repair or modification to the machine controls, tooling or the OS32C system. See page 127.

Perform only the test and repair procedures outlined in this manual.

Additional measurement error resulting from reflective backgrounds may need to be added to the measurement error of the OS32C.

To use the protective function of the OS32C, a safety zone must be properly defined and configured.

If the response time is changed, re-calculation of the safety distance is required. This may require re-configuration of the safety zones or re-installation of the OS32C. If the safety distance is not appropriate for the application, the machine may not stop before contact with the hazardous part, resulting in serious injuries or death.

When using more than one OS32C, mutual interference should be prevented. This may require different scanner positions or physical shields to be installed.

To ensure a protection degree of IP65, DO NOT use this product without proper sealing of the cable connector, I/O block, and scan window.

If the external zone switching device momentarily exceeds the configured number of active zone set select inputs during the zone switch, an additional Zone Delay may be incurred in the event that wiring of a zone set select input fails. The external zone switching device must properly sequence so the configured number of active inputs is not exceeded in order to guarantee that failed zone set select input wiring will be detected within the normal Zone Switching Time described below.

If an insufficient Zone Delay is used for the actual worst case switching time of the installation, the scanner might start monitoring the wrong zone during the switching period.
Also, if an insufficient Zone Delay is used for the actual worst case switching time of the installation, there might be a fault condition during the zone switching period.

If t_{start} is configured without consideration of $T_{maxReaction}$, object detection within the new safety zone after switching and turning OFF of the safety outputs may be delayed.

Wiring Connections

⚠ WARNING

Do not connect the OS32C to a power supply with more than 24VDC + 25% / -30%. Do not supply AC power to the OS32C, this may result in electrical shock.

For the OS32C to meet IEC 61496-1 and UL 508, its DC power supply unit must satisfy all of the following conditions:

- •Within rated line voltage (24 VDC +25% / -30%)
- •Complying with EMC directives (industrial environments)
- •Double-insulation or reinforced insulation between primary and secondary circuits
- •Automatic return for overcurrent protection
- •Output retention time of 20 ms or longer
- •Satisfying output characteristics requirements of Class 2 circuit or limited voltage/current circuit defined in UL508.
- •Power supply complying with regulations and standards of EMC and safety of electrical equipment in a country or a region where OS32C is used. (Example: In EU, a power supply must comply with EMC directives for low-voltage)

To prevent electrical shock, use double-insulation or reinforced insulation from hazardous voltage (such as 230 VAC).

Cable extensions must be within the specified lengths, otherwise it may result in a failure of the safety functions.

To use this product for a category 3 safety system, both safety outputs must be connected to the safety system. Configuring a safety system with only one safety output may result in serious injuries due to output circuit fault and a failure of the machine to stop.

Protection of Cable at Installation:
Care should be taken when installing the OS32C cable. The cable must be properly routed and secured to ensure that damage does not occur.

Functional Earth:
The OS32C system requires a functional earth connection.
Do not connect Functional Earth to a positive ground system. If it is connected to positive ground, the guarded machine to be controlled may NOT stop, resulting in severe operator injury.

Signal Connector Isolation:
The connectors used during installation must provide sufficient signal separation in order to prevent a short circuit condition of the input power and system signals.

Others

⚠ WARNING

Do not modify the main unit of the OS32C. Do not replace or fix any component of the OS32C other than the ones specified in this manual. Doing so may result in a failure of this device to function correctly.

If there is any damage to the window, replace them as soon as possible. Otherwise it may result in a failure of the OS32C. Take preventive measures when performing replacement work so that dust does not enter the OS32C.

Always detach all cables from the OS32C before replacing the scan window. Otherwise the motor may start rotating, resulting in injuries.

The tests outlined in this Test Procedure (See "Checkout and Test Procedure Log" in p.127) must be performed at time of installation, according to the employer's regular inspection program and after any maintenance, tooling change, set up, adjustment, or modification to the OS32C system or the guarded machine. Where a guarded machine is used by multiple operators or shifts, it is suggested that the test procedure be performed at each shift or operation change and also if there is a change in the OS32C operating mode or defined zone sets. Testing ensures that the safety laser scanner and the machine control system are working properly to stop the machine. Failure to test properly could result in serious injury to personnel.

If the OS32C is operated under automatic start, make sure that the machine stops and does not restart as long as an object is detected in a safety zone. Check the operation by placing a test piece into the safety zone. It is recommended to perform the test at least after a shift change or 24 hours of operation.

If the safety system or the machine fails any of these tests, do not run the machine. Immediately tag or lock out the machine to prevent its use and notify the appropriate supervisor.

⚠ CAUTION

When transferring data from the PC to the OS32C and more than one OS32C is connected to the network, it is necessary to visually check the diagnostic code on the status/diagnostic display. It is recommended that the OS32C be installed in a position where the status/diagnostic display will be visible.

Take precautions to prevent dirt, dust or debris from entering the sensor and I/O block connectors. It is recommended that this be done on a clean workstation as contaminants may degrade the performance of the OS32C.

Adhesion of dust to the scan window may cause a false operation. The OS32C will require periodic cleaning of the scan window and dust detection surface.

Operation of the OS32C may be affected by light in the environment, such as incandescent light, strobe light and light from a photosensor using infrared light.

Operation of the OS32C may be affected by substances in the environment, such as fog, smoke, steam and other small particles.

Precautions for Safe Use

Make sure to follow all the safety precautions that are necessary to ensure safe use of the product.

- Thoroughly read this installation manual and understand the installation, operation checks, and maintenance procedures before using the product.
- Loads must satisfy both of the following conditions:
  - -Not short-circuited
  - -Not used with a current that is higher than the OSSD rating (250 mA sourcing)
- The main unit must be properly mounted with the proper mounting hardware.
- Do not drop the product, serious damage will occur.
- Comply with all the laws, regulations, and standards of the country/region where the product is used.
- Dispose of the product in accordance with the relevant rules and regulations of the country/region where the product is used.

Precautions for Correct Use

Observe the precautions described below to prevent operation failure, malfunctions, or undesirable effects on product performance.

■ Installation environment

Do not install the OS32C in the following types of environments:

- •Areas where OS32C may be exposed to intense interference light, such as direct sunlight
- •Areas with high humidity where condensation is likely to occur
- •Areas where corrosive gases are present
- •Areas exposed to vibration or shock levels higher than in the specification provisions
- •Areas where the product may come into contact with water
- •Areas where the product may get wet with oil
- •Areas where smoke and/or water vapor exists on the laser scanning plane

This is a class A product. In residential areas it may cause radio interference, in which case the Responsible Person may be required to take adequate measures to reduce interference.

■ Wiring and installation

- •Make sure to perform wiring while the power supply is OFF. Otherwise, the OS32C may fail to operate due to the diagnostics function.
- •Properly perform the wiring after confirming the signal names of all the terminals.
- •Do not operate the control system until 8.5 seconds or more after turning ON the power of the OS32C.
- •Be sure to route the OS32C cable separate from high-potential power lines or through an exclusive conduit.
- •When using a commercially available switching regulator power supply, make sure to ground the FG terminal (frame ground terminal).

■ Cleaning

Do not use thinner, benzene, or acetone for cleaning. They will adversely affect the product's resin parts and paint on the case.

■ Object detection

The OS32C has a resolution of 70mm, it can detect objects with a diameter of 70mm or larger. It cannot detect transparent or translucent objects, or objects with reflective surfaces, of less than 1.8%.

How to Read This Manual (Explanation of Symbols)

Indicates the description of an essential function, such as operation or advice on how to properly use this product .

Indicates the page number for related content.

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Chapter1 Description of Use and Features

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Theory of Operation

The OS32C safety laser scanner is an optical safety sensor that uses diffuse reflection of a pulsed laser light to determine the location of objects entering a predefined monitoring zone. Internally, a spinning mirror assembly scans a monitoring zone by sending a pulse of light which reflects off the first object in its path. The distance from the sensor to the object is determined by measuring the time that the light requires to return from the sensed object.

This method of sensing allows for standard, simple or irregular shapes to be used as the predetermined sensed monitoring zones. It also allows for the monitoring zone to be changed if the hazardous area changes. Using diffused reflection of light back to the OS32C precludes the need for a traditional transmitter/receiver pair.

Within the sensing range of the OS32C, three fields can be monitored simultaneously: One safety zone and two warning zones.

- One Safety Zone is used to detect personnel or other objects entering an area that has been determined to be a hazard. Upon sensing that the object is within the Safety Zone, the OS32C will send a stop signal to the control circuitry of the machine being guarded.
- Two Warning Zones can be defined with a longer distance than a safety zone, allowing a configuration to detect objects that are closely approaching the hazardous area of the Safety Zone before the actual Safety Zone is encroached.

Applications for the OS32C include mobile applications on automatic guided vehicles (AGV) or transfer carts as well as stationary use, such as within a robotic work cell, in front of a press or around other hazardous machinery.

Features

- Can detect intrusions within the safety zone with a radius of 3m and two warning zones with a radius of 10m, covering a maximum scan angle of 270°.
- When an object is detected within the safety zone, individual sector indicators immediately turn on (8 red indicators), indicating the object's position of intrusion.
- Seventy sets of safety zone and warning zone combinations are available, supporting complicated changes of working environments.
- The configuration software allows easy to use monitoring zone configuration.
- A safety relay can be directly monitored by the external device monitoring function.
- The physical mounting position of the safety laser scanner can be monitored by the reference boundary monitoring function.
- Compact design allows for low-clearance installations.

System Components

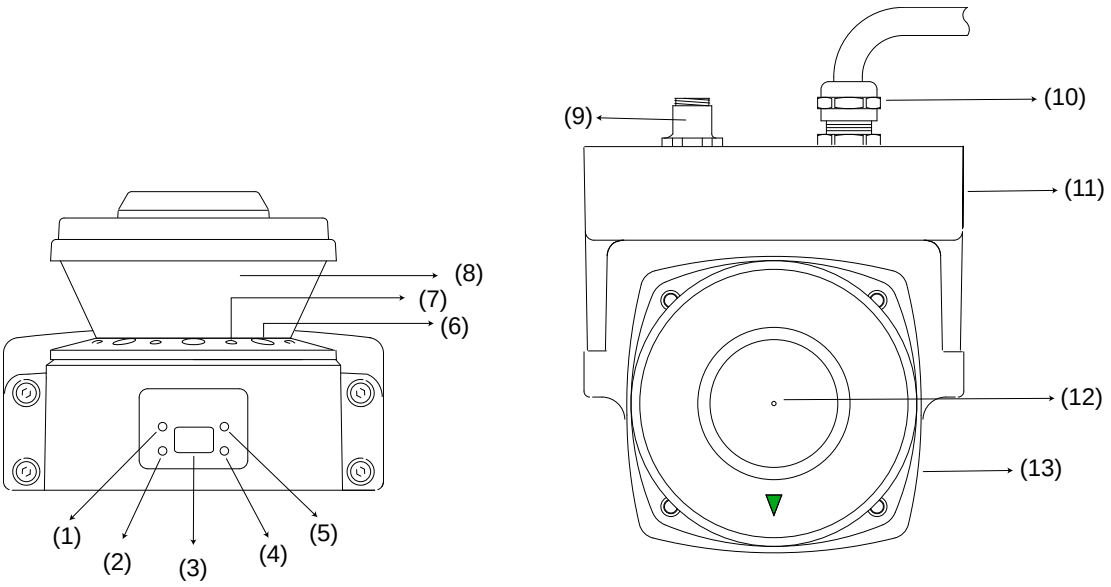

Fig. 1-1 System Components

Number	Component	Function
(1)	RUN indicator (green)	Will turn ON when safety zone is clear and OSSDs are ON.
(2)	Interlock Indicator (yellow)	Will turn ON when in interlock state, blink under lockout, and blink in case of a failure.
(3)	Status/Diagnostic Display	The scanner's status ,configuration/operation, or failure is displayed
(4)	Warning Output Indicator (orange)	Will turn ON when the warning output is ON.
(5)	STOP indicator (red)	Will turn ON when safety zone is blocked, OSSD are OFF or under interlock state.
(6)	Dust Ring	Dust detection cover with reflective surface, for dust accumulation detection
(7)	Individual Sector Indicators	Will turn ON when an intrusion is detected in the safety zone, 8 sectors total. Each sector = 33.75°.
(8)	Scan Window	The window where the laser light is emitted and received.
(9)	Communication Connector	Provides for Ethernet interface.*1
(10)	Power Connector	For power connections, 18-pin connector (pigtail).*1
(11)	I/O Block	Connector module
(12)	Center of rotation	Indicates the location of the axis around which the laser irradiates from.
(13)	Sensor	Sensor head; field replaceable.

*1: The communication and power connections can also be mounted on the left side of the I/O block.

Table 1-1 System Components and Indicators

For details on indicators, refer to "Indication Patterns" on page 14.

For details on Status/Diagnostic Display, refer to "OS32C Status Check" on page 111.

Application Examples

The OS32C may be used for personnel safeguarding. Typical applications include work cell area guarding and collision prevention of AGV (Automated Guided Vehicles). The OS32C is a versatile Safety Laser Scanner capable of guarding many types of applications. The application examples in this chapter are for informational and instructional purposes only and not intended to represent complete guarding solutions. Care must be taken to ensure that all aspects of a machine or work cell are reviewed and appropriate guarding techniques are employed.

Applying the OS32C to fixed stationary applications

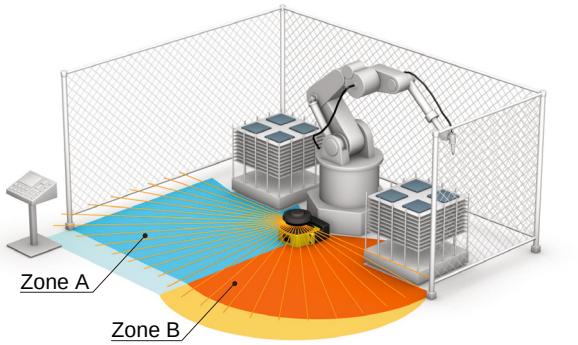

Fig. 1-2 Dual Zone Area Guarding

In this application the OS32C is the primary guarding device, using a horizontal protective field for area protection. The OS32C will guard one side of the area based on the robot's position. This application takes advantage of the multi-zone functions of the OS32C. This function allows an operator to enter and set-up on one side "the safe side" shown as Zone A, while the robot performs its tasks on the "hazardous side" shown as Zone B. The warning zones are represented by the lighter colors. The robot's position is determined via external devices that provide discrete inputs to the OS32C.

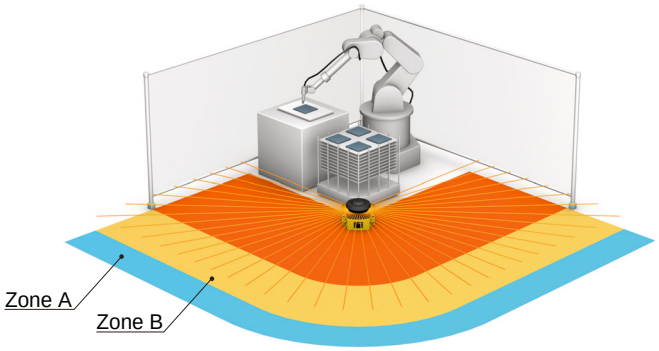

Fig. 1-3 270 deg. Area Guarding

In this application the OS32C is the primary guarding device, using a 270 degree horizontal protective field for area protection guarding. The production process in this example does not allow for any frontal hard guarding obstructions in front of the work cell. The warning fields (shown as Zone A & Zone B) of the OS32C provides manufacturing personnel with a preliminary warning to prevent them from accidentally stopping the manufacturing process. In some cases an unintentional interruption can result in very high waste costs.

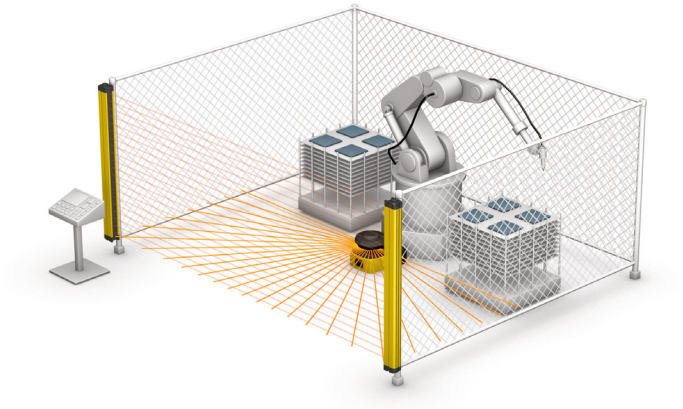

Fig. 1-4 Internal Robot Cell Guarding

In this application the OS32C is the secondary guarding device in conjunction with a safety light curtain. The OS32C is responsible for detecting that the work area is clear before start-up of the robot occurs.

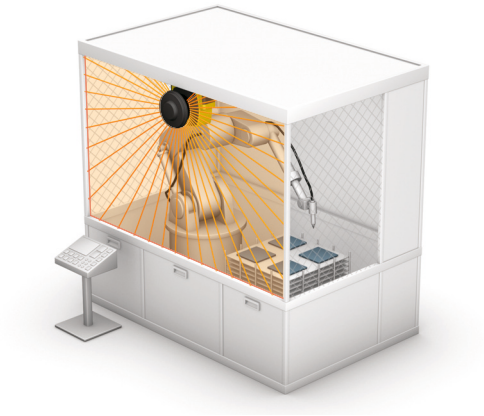

Fig. 1-5 Vertical Guarding Installation

In this application the OS32C is the primary guarding device, using a vertical protective field for point of operation guarding. In some cases the machine's architecture or production flow may not permit the installation of a safety light curtain. The OS32C meets all the requirements of IEC 61496-3 for vertical guarding installations and employs a reference boundary monitoring function.

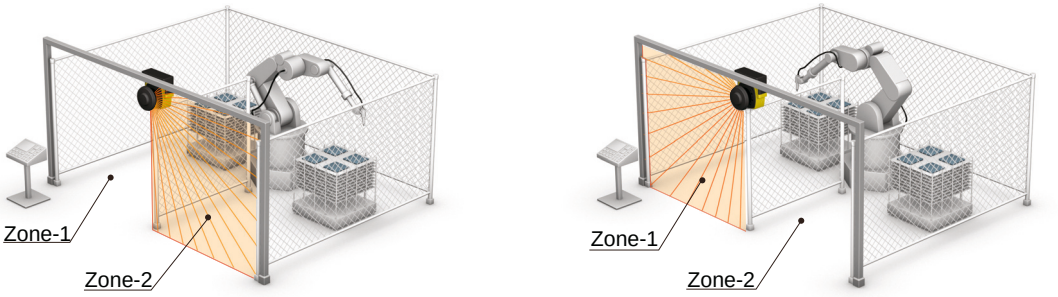

Fig. 1-6 Dual Zone Vertical Guarding

In this application the OS32C is the primary guarding device, using a vertical protective field for entry presence detection. The OS32C can guard the hazardous area based on the robot's position. When the robot is in the left side, the OS32C guards the left side and changes to the right side along with the robot. This application takes advantage of the multi-zone functions of the OS32C. This function allows an operator to enter and set-up on one side, "the safe side", while the robot performs its tasks on the hazardous side. The robot's position is determined via external devices that provide discrete inputs to the OS32C. The OS32C meets all the requirements of IEC 61496-3 for vertical guarding installations and employs a reference boundary monitoring function.

Applying the OS32C on Automated Guided Vehicles (AGV)

Unmanned automated vehicles require guarding devices to prevent accidental collisions. The OS32C will scan the path of the AGV and will send a stop signal to the vehicle if it detects an object or person. The OS32C is more adjustable and reliable than conventional pressure-sensitive bumpers.The OS32C's flexibility allows three types of monitoring.

See Fig. 1-7

■ Warning Zone 1 Detection

The warning output will send a signal to the AGV when Warning Zone 1 is infringed. Thiswill trigger the vehicle to sound an alarm, allowing a person to move away from the vehicle's path.

■ Warning Zone 2 Detection

The auxiliary output will send a signal to the AGV when Warning Zone 2 is infringed. This will trigger the vehicle to slow down, allowing a person to move away from the vehicle's path.

■ Safety Zone Detection

The two safety outputs will send an E-stop to the AGV when the Safety Zone is infringed. This will signal the vehicle to come to a complete stop.

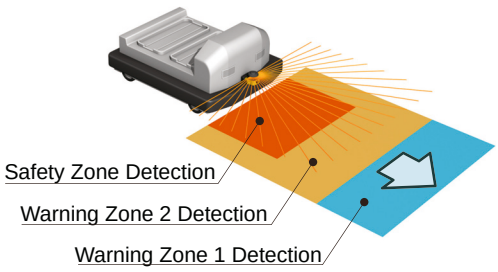

Fig. 1-7 AGV Navigation

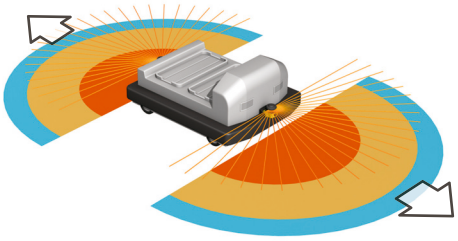

Fig. 1-8 Automated Guided Vehicles, Bi-directional (AGV)

In this application two OS32Cs are the primary guarding devices. The two warning fields of the OS32C are used to give personnel extra warning, allowing them to move out of the AGV path. This is essential in achieving maximum travel efficiency.

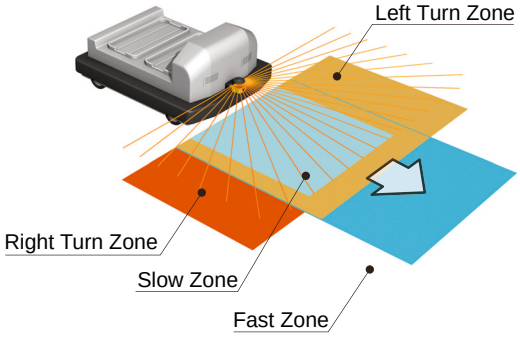

Fig. 1-9 Automated Guided Vehicles, Multiple Zones (AGV)

In this application the OS32C is the primary guarding device. The drawing illustrates a common AGV guarding configuration where 4 zone sets are used to safely navigate the vehicle around a factory floor. The four zone sets consist of two for forward motion (high speed, low speed), one for left turn and one for right turn. The active safety zone set is selected by the AGV's controls, which are configured for maximum efficiency.

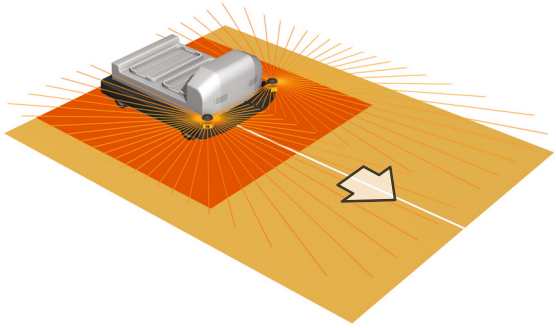

Fig. 1-10 Automated Guided Vehicles (AGV), Two Scanners, Three Sided

In this application two OS32Cs are used as the primary guarding devices, using 270 degree protective fields. They are positioned at the front corners, this scheme allows for two scanners to guard three sides of the AGV. This configuration is appropriate for AGVs that can maneuver in three directions, forward and side-to-side.

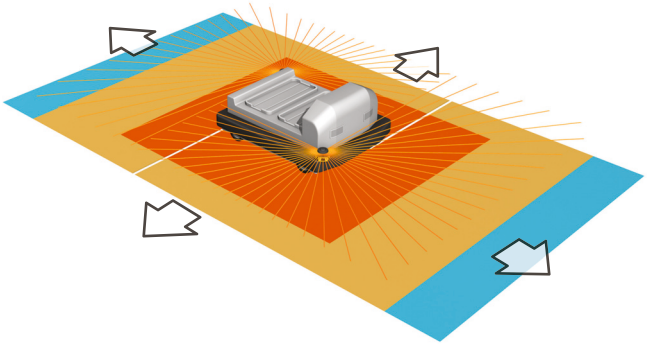

Fig. 1-11 Automated Guided Vehicles (AGV), Two Scanners, Four Sided

In this application two OS32Cs are used as the primary guarding devices, using 270 degree protective fields. They are positioned at opposite corners. This scheme allows for two scanners to guard four sides of the AGV. This configuration is appropriate for AGVs that can maneuver in four directions, forward, reverse and side-to-side.

Rating/Performance

Sensor Type		Type 3 Safety Laser Scanner
Safety Category		Category 3, Performance Level **d** (ISO13849-1: 2006)
Functional Safety of Electrical/Electronic/ Programmable Electronic Safety-related Systems		SIL 2 (IEC61508)
Detection Capability		Non-transparent with a diameter of 70mm (1.8% reflectivity or greater)
Monitoring Zone		Monitoring Zone Set Count (Safety Zone + 2 Warning Zones) : 70 sets max.
Operating Range		Up to a radius of 3m for Safety Zone, 10m for Warning Zones
Maximum Measurement Error		100mm *1
Detection Angle		270°
Angular Resolution		0.4 degree
Laser Beam Diameter		6mm at optics cover, 14mm (typical) at 3m.
Response Time		Response time from ON --> OFF: From 80ms (2 scans) to 680ms (up to 17 scans) Response time from OFF --> ON: Configurable. See Table 7-2 on page 113.
Zone Switching Time		From 20 to 320 ms
Line voltage		24VDC +25%/-30% (ripple p-p 2.5V max.) *2
Power Consumption		Normal operation: 5Wmax., 4W typical (without output load) *3 Standby mode: 3.75W (without output load)
Emission Source (Wavelength)		Infrared Laser Diode (905nm)
Laser Protection Class		Class 1: IEC/EN60825-1(2007)
		Class 1: JIS 6802(2005)
		Class I: CFR21 1040.10, 1040.11
Safety Output (OSSD)		PNP transistor x 2, load current of 250mA max., residual voltage of 2V max., load capacitance of 2.2 µf max., leak current of 1mA max *3, *4, *5.
Auxiliary Output (Non-Safety)		NPN/PNP transistor x 1, load current of 100mA max., residual voltage of 2V max., leak current of 1mA max *4, 5, 7
Warning Output (Non-Safety)		NPN/PNP transistor x 1, load current of 100mA max.,residual voltage of 2V max., leak current of 1mA max *4, 5, 7
Operation Mode		Auto Start, Start Interlock, Start/Restart Interlock
Input	External Device Monitoring	ON: 0V short (input current of 50mA), OFF: Open
	Start	ON: 0V short (input current of 20mA), OFF: Open
	Zone Select	ON: 24V short (input current of 5mA), OFF: Open
	Standby	ON: 24V short (input current of 5mA max.), OFF: Open
Connection Type		Power Cable: 18-pin mini-connector (pigtail)
		Communication Cable: M12, 4-pin connector
Connection with PC		Communication: Ethernet *6
		OS Supported: Windows 2000, Windows XP, Windows Vista
Indicators		RUN indicator : Green, STOP indicator : Red, Interlock Indicator : Yellow, Warning/Auxiliary Output Indicator : Orange
		Status/Diagnostic Display: 2 x 7-segment LEDs, Individual Sector Indicators: Red LED x 8
Protective Circuit		Protection against output load short and reverse power connection
Ambient Temperature		Operation: -10 to 50 deg. C, Storage: -25 to 70 deg. C
Ambient Humidity		Operation & Storage: 95%RH max., non-condensing
Ambient Operation Illumination		Incandescent lamp: Illumination on receiving surface 1500lx max. (an angle of laser scanning plane and disturbance light must be +/-5 degrees or more)
Insulation resistance		20Mega-ohm or higher (500VDC)

Dielectric withstand voltage	350VAC, 50/60Hz, 1 minute
Enclosure Rating	IP65(IEC60529)
Enclosure	Sensor Head: Die-cast aluminum
	Optics Cover: Polycarbonate
	I/O Block: Die-cast aluminum
Dimensions (WxHxD)	133.0 x 104.5 x 142.7mm (except cable)
Impact Resistance	98m/s^2 1000 times for each of X, Y, and Z directions (IEC60068-2-29)
Vibration	10~55Hz double-amplitude of 0.7mm, 20 sweepings for X, Y, and Z directions (IEC60068-2-6)
Weight (Main Unit only)	1.3kg
Power Cable	Up to 30m
Communication Cable	Up to 100m for 100 BASE-T Cat 5 cable
Approvals	Certificated by: TÜV Rheinland, UL
	Major Standards: IEC61496-1/-3 Type 3, ISO13849-1:2006 Category 3, UL508, UL1998

*1. An additional measurement error may need to be added due to reflective backgrounds (See p.114 for details).
*2. For power source specification, see Power Supply Unit in p.96
*3. Rated current of OS32C is 1.025A max. (OS32C 210mA + OSSD A load + OSSD B load + Auxiliary output load + Warning output load + Functional Inputs).
Where functional inputs are:
EDM input ... 50mA
Start input ... 20mA
Standby input ... 5mA
Zone X input ... 5mA x 8 (eight zone set select inputs)
*4. Output voltage is Input voltage - 2.0VDC.
*5. Total consumption current of 2 OSSDs, auxiliary output, and warning output must not exceed 700mA.
*6. An ethernet cable with an M12, 4-pin connector is required.
*7. Output polarity (NPN/PNP) is configurable via the configuration tool.

Table1-2 OS32C Specifications

Chapter2 Operating States & Output Modes

Operating States 14

Operating Mode 16

- Automatic Start 16
- Start Interlock 16
- Start/Restart Interlock 16
- Power Reserve Mode 16

Parameter Configuration 17

- Safety Critical Parameters 17
- Non-Safety Critical Parameters 18

Safety Outputs 19

Auxiliary & Warning Outputs 19

Reference Boundary Monitoring (RBM) 21

Zone Set Selection 22

- Zone Set Input Selection 22
- Zone Set Switching 24

Operating States

The following operating states exist for the OS32C system.

1. OSSD ON State

The two safety outputs are in the ON state, and the machine run (green) indicator is lit. The protected machine is allowed to operate. The state/diagnostic display indicates a state of monitoring zone set selection and a response time.

2. OSSD OFF State

An object exists in a safety zone and it is being detected. The two safety outputs are in the OFF state, and the machine stop (red) indicator and the intrusion indicators in the affected region(s) are lit. The protected machine is not allowed to operate. The status/diagnostic display shows "- -".

3. Interlock State

This state waits for a start input (See p.16 for details.). The two safety outputs are in the OFF state, the red STOP indicator and yellow interlock indicator are lit. The protected machine is not allowed to operate. The status/diagnostic display shows "01".

4. Lockout State

A failure is being detected and the guarded machine is being stopped. The two safety outputs are in the OFF state, the machine stop (red) indicator is lit and yellow interlock indicator is flashing. The protected machine is not allowed to operate. The status/diagnostic display shows the error code that caused the lockout. The OS32C system will remain in the lockout state until the problem is corrected and a start input is applied or power on the unit is cycled.

■ Indication Patterns

RUN indicator (Green LED)	On	When OSSD is ON
	Off	When OSSD is OFF
STOP indicator (Red LED)	On	When OSSD is OFF
	Off	When OSSD is ON
Interlock Indicator (Yellow LED)	On	Interlock State
	Flashing	Lockout State (@ 1Hz), Configuration State (@ 4Hz)
	Off	Other than the above
Warning output indicator (Orange LED)	On	When any warning zone is intruded
	Flashing	When dust or contamination is detected on the scan window (@ 1 Hz)
	Off	Other than the above
Status/Diagnostic Display	□□	See "OS32C Status Check" on page 111.
Individual Sector Indicators (Red LED)	On	When an object is in any safety or warning zone. *1, *2
	Flashing	When dust or contamination is detected on the scan window. *1
	Off	Zones are clear and window is clean.

*1 The functionality of the intrusion indicators is configurable via the configuration tool.

*2 The intrusion indicators in the affected region is lit or flashing.

Table 2-1 Indication Patterns

State	RUN indicator (Green LED)	STOP indicator (Red LED)	Interlock indicator (Yellow LED)	Warning output indicator (Orange LED)	OSSDs
Power On Self Test	On	On	On	On	Off
Machine Stop	Off	On	Off	Depends on configuration and object position	Off
Machine Run (Normal Operation)	On	Off	Off	Depends on configuration and object position	On
Machine Run (Dust on scan window)	On	Off	Off	Flashing (@ 1 Hz)	On
Interlock	Off	On	On	Depnds on configuration and object position	Off
Standby	Off	On	Off	Off	Off
Fault (Dust on scan window)	Off	On	Flashing (@ 1Hz)	Flashing (@ 1 Hz)	Off
Fault (others)	Off	On	Flashing (@ 1Hz)	Off	Off
Configuration	Off	On	Flashing (@ 4Hz)	Off	Off

Table2-2 OS32C Operating States and Corresponding Outputs

Operating Mode

Automatic Start

After power on, OS32C automatically enters machine run (ON) state if no fault is detected during initialization and self-tests, and if no intrusion is detected within the safety zone. An object entering the safety zone shall turn the OSSDs OFF. Once the safety zone is clear, the sensor will automatically enter the machine run (ON) state.

Start Interlock

After power on, OS32C automatically enters the interlock state if no fault is detected in its system initialization and self-tests, and if no intrusion is detected within the safety zone. To release the interlock state, a start input must be applied for 200ms or longer. Once the interlock state is released and OS32C enters the machine run (ON) state, an object entering the safety zone will turn the OSSDs OFF. Once the safety zone is clear, the sensor will automatically enter the safety output ON state.

Start/Restart Interlock

After power on, OS32C automatically enters the interlock state if no fault is detected in its system initialization and self-tests, and if no intrusion is detected within the safety zone. To release the interlock state, a start input must be applied for 200ms or longer. Once the OS32C has started and enters the machine run (ON) state, an object entering the safety zone will turn the OSSDs OFF. Once the safety zone is clear, the sensor will enter the interlock state.

Power Reserve Mode

Power reserve mode allows the OS32C to enter a state of reduced power consumption. This is a very useful mode when the OS32C is installed on a battery powered AGV. This mode can be configured for Standby Mode:

- •OSSDs, AUX and WARNING outputs will be off.
- •Individual Sector indicators will be deactivated.
- •Diagnostic display will display “- -”, which blinks once every 2 seconds.
- •Wake-up time (time it takes for the OS32C to return to normal mode) is less than 0.5s.

To use Standby mode:

- •Enable Standby mode under the Power Reserve property and send this change to the scanner.
- •Wire the standby input to a normally open contact, see Chapter 5 for wiring diagram.

To activate standby mode:

- •The closure of a normally open contact needs to connect the standby input line to +24VDC.

Parameter Configuration

The configuration properties consist of two sections: Safety-Critical Parameters and Non-Safety Critical parameters.

Safety Critical Parameters

■ External Device Monitoring (EDM)

External device monitoring is an important safety function. It verifies that the external control elements are responding correctly.

The OS32C can operate with this feature enabled or disabled. To use external device monitoring, the OS32C requires that a Normally Closed contact from each Control Element be fed back in for monitoring. If these contacts do not respond as expected the OS32C will enter the lockout state and turn off the safety outputs.

In the safety output ON state, the OS32C expects to see the external device monitoring input open. In the safety output OFF state, the OS32C expects to see the external device monitoring input closed. The external device monitoring inputs must change state within 300ms after a change of the OS32C's safety outputs or lockout will occur.

■ Response Time

The response time of the OS32C is proportional to the number of scans. The safety outputs will change from on to off within a preset response time. The response time can be set from 80ms to 680ms. The number of scans may be increased when operating the OS32C in a dirty environment to avoid nuisance trips caused by floating particulate matter.

Application Example	Example of Response Time
Stationary (clean environment)	80ms
Mobile	80ms - 240ms
Stationary (Dirty environment)	More than 240ms

Table 2-3 Response Time Examples

⚠ WARNING

If the response time is changed, re-calculation of the safety distance is required. This may require re-configuration of the safety zones or re-installation of the OS32C. If the safety distance is not appropriate for the application, the machine may not stop before the hazardous area is reached, resulting in severe injuries.

■ Zone Set Selection

The OS32C is capable of monitoring up to seventy zone sets, where a zone set is defined as one safety zone with a maximum range of 3m, and two warning zones with a maximum range of 10m. These zone sets can be controlled via programmable selectable inputs. The installer has the ability of deciding how many and which inputs to use with the configuration software.

For more information on Zone Set Switching, see page 24.

■ Zone Set Select Input Combinations

When multiple zones are selected, the zone set select input combination table must be configured. These settings will be determined by the number of zones needed and available inputs.

■ Zone Transition Delay

When multiple zones are used the transition time must be accounted for in the safety distance calculation. This delay is 10 ms. This would show up as an additional component, t_3, of T in the Safety Distance calculation on page 81. The $t_3$delay does not apply in applications without multiple zones.

Non-Safety Critical Parameters

■ Auxiliary Output Mode

There are five possible auxiliary output settings: safety output information mode, lockout information mode, warning zone 1 infringed mode, warning zone 2 infringed mode, and window contamination warning mode.

■ Warning Output Mode

There are five possible warning output settings: safety output information mode, lockout information mode, warning zone 1 infringed mode, warning zone 2 infringed mode, and window contamination warning mode.

■ Restart Delay (Machine Stop to Machine Run Time Adjustment)

This parameter is configurable when the OS32C has been configured to operate in Automatic Start Mode.

Please see page 113 for more information.

■ Power Reserve Mode

See Power Reserve Mode on page 16.

Safety Outputs

⚠ WARNING

This product is designed for use on a 24 VDC, negative ground (protective earth) electrical system only. Never connect the OS32C to a positive ground (protective earth) system. With a positive ground (protective earth) wiring scheme, certain simultaneous shorts of both safety outputs may not be detected and the guarded machine may not stop resulting in severe injury to the operator.

To use this product for a category 3 safety system, both of the two safety outputs must be used to build the safety system controls circuit. Configuring the safety control system with only one safety output may result in serious injuries due to output circuit failure.

The OS32C provides two PNP safety outputs, each capable of sourcing 250 mA @ 24 VDC. These two outputs can be connected to the machine's primary control element, or may be used to connect to a control device. The safety outputs will turn on when the safety zone is clear, and the guarded machine can operate. The OS32C will turn off its safety outputs when it detects an intrusion in the safety zone, and the guarded machine stops. In addition, the OS32C will test the safety outputs by switching the outputs off for <600µs every ~5 min. See Fig. 2-1 below.

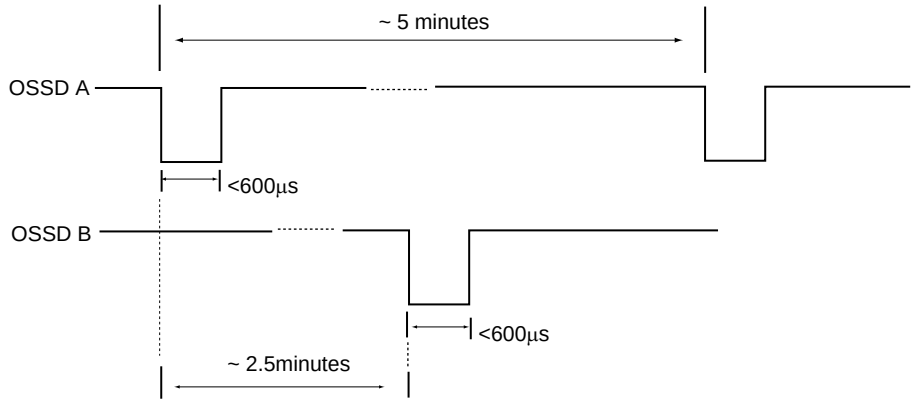

Fig. 2-1 OSSD Test Pulses

Auxiliary & Warning Outputs

The OS32C has a non-safety auxiliary output and a non-safety warning output, max.100mA @ 24VDC. Both the output type (PNP/NPN) and polarity (Active ON/Active OFF) can be configured. These outputs can be configured to operate in one of the following modes:

- Follow OSSD indication: output will turn ON when the machine stops.
- Indicate FAULT: output will turn ON when a fault has occurred.
- Warning Zone 1 infringed: output will turn ON when an intrusion is detected in warning zone 1.
- Warning Zone 2 infringed: output will turn ON when an intrusion is detected in warning zone 2.
- Window Contamination Warning: output will turn ON when contamination of the scan window reaches a certain level.

Output Mode	Active ON	Active OFF
Disabled	Output always OFF	Output always OFF
Safety Output Information Mode	Same as OSSDs (output ON when safety zone is clear)	Opposite of OSSDs (output OFF when safety zone is clear)
Lockout Information Mode	Output ON when fault occurs	Output OFF when fault occurs
Warning Zone 1 Information Mode	Output ON when zone 1 infringed	Output OFF when zone 1 infringed
Warning Zone 2 Information Mode	Output ON when zone 2 infringed	Output OFF when zone 2 infringed
Window Contamination Warning Mode	Output ON when window contaminated	Output OFF when window contamined

NOTE: If the unit enters a fault state, all outputs will be OFF, except in Lockout Information Mode.
Fig. 2-2 Output Polarity

Reference Boundary Monitoring (RBM)

The OS32C has the ability to reference and monitor the presence of pre-determined areas (beams) within the boundary being guarded, i.e. walls, doorways, etc. Reference boundary monitoring (RBM) is normally used in vertical guarding installations, see Fig. 2-3.

The RBM function allows users to select certain areas on the detection zone (safety or warning) boundary and program them to detect continuous presence. This function is intended to prevent unauthorized changes in the physical position of the OS32C scanner.

For a reference boundary area to be valid, the selected group of consecutive beams must span a distance of 70mm (equivalent to the OS32C's resolution). The selected areas can also be specifically tuned (user-defined) for accuracy detection tolerance

- When RBM is enabled for the safety zone, the area (beams) that has been activated will cause a transition to a machine stop state when a distance change is sensed.
- When RBM is enabled for a warning zone, the area (beams) that has been activated will cause a transition of the corresponding auxiliary output when a distance change is sensed.

For complete directions on setting up reference boundary monitoring, see page 58.

Per the international standard IEC 61496-3, area scanners used in applications where the angle of approach exceeds +/- 30 degrees with respect to the detection plane, must use reference boundary monitoring (RBM) of the detection zone. The tolerance zone for (RBM) must NOT exceed 100mm.
The OS32C response time must not exceed 120ms, as the OS32C must detect objects moving at 1.6 meters per second. If the detection zone is infringed or if the detection zone boundaries are changed, the scanner shall turn off the two OSSD outputs

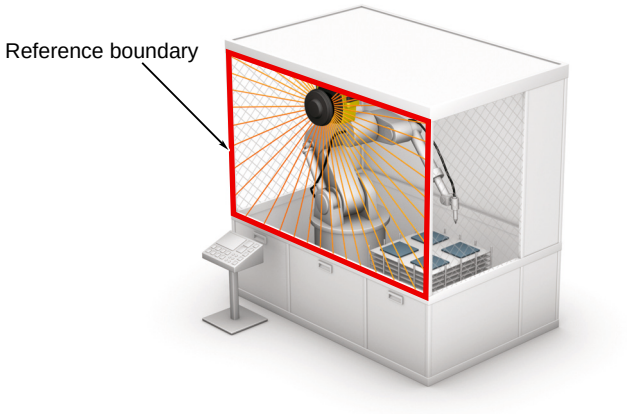

Fig. 2-3 Reference Boundary Monitoring

Zone Set Selection

Zone Set Input Selection

When configured for multiple zones, there are a total of 8 inputs available for zone set selection for the OS32C; it is not necessary to use them all. The minimum requirement for safe operation is 2 total inputs. The user must also configure the total number of inputs (the number of input terminals to be used) and active inputs (the number of inputs to be activated) needed to select a zone set. During operation, the scanner will always monitor for that specific configuration of inputs to be active.

Once the number of inputs and active inputs is configured, the user is able to define and assign the detection zone sets to each combination of inputs. The number of unique active combinations available depends on the number of total inputs and the number of active inputs. Table 2-4 shows the maximum number of zone sets possible for the various configurations. It is not necessary to have a zone assigned to every possible combination. Unassigned combinations are assumed to be invalid.

		No. of Total Inputs (n)						
		8	**7**	**6**	**5**	**4**	**3**	**2**
Total No. of Active Inputs (r)	**1**	8	7	6	5	4	3	2
	2	28	21	15	10	6	3	
	3	56	35	20	10	4		
	4	70	35	15	5			
	5	56	21	6				
	6	28	7					
	7	8						

$$\text{Maximum number of zones} = \frac{n!}{r! * (n-r)!}$$

Table 2-4 Maximum number of combinations, depending on total number of inputs and total number of active inputs.

The examples below are some of the possible configurations that can be accomplished for many applications. Here z1 and z2 are used as abbreviations of zone set select input 1 and 2.

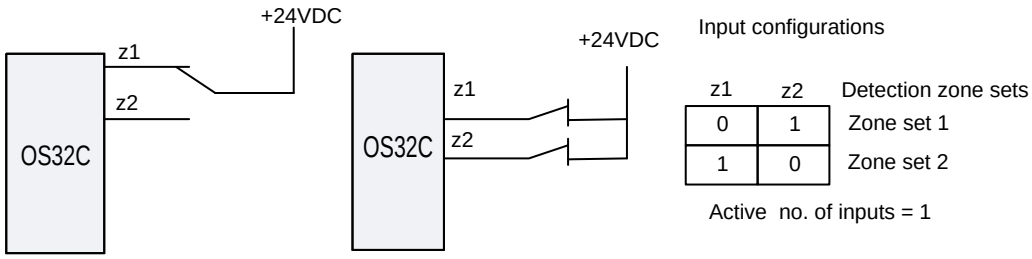

Fig. 2-4 Two-Zone Set Application

The examples above illustrate two different wiring schemes that use two inputs with one active required. This is used for a two-zone set application.

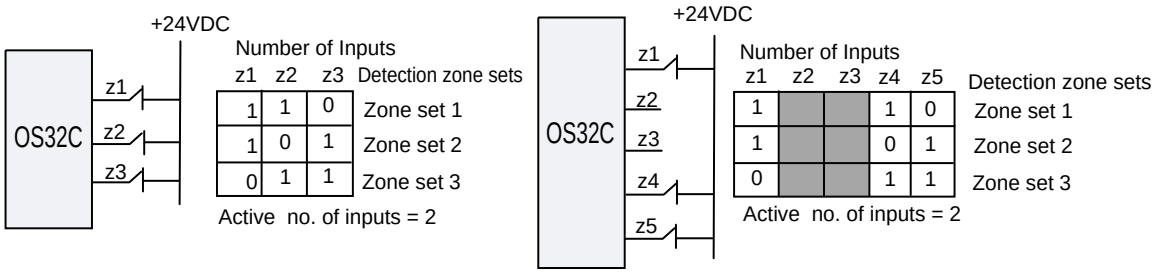

Fig. 2-5 Three-Zone Set Application

The examples above illustrate a wiring scheme that uses three inputs with two active required. This is used for a three-zone set application. Note that the selection of inputs is programmable; the user has the ability to select which inputs to use. These configurations are technically the same, but different inputs are selected as active.

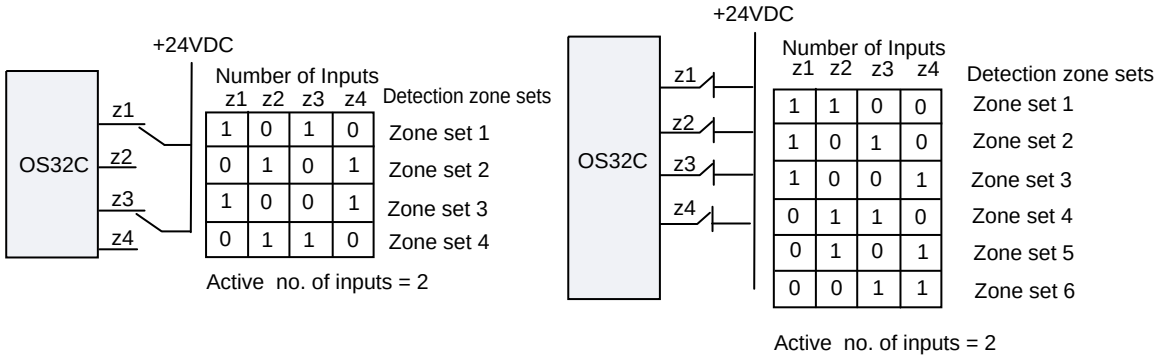
+24VDC
OS32C
z1
z2
z3
z4
Number of Inputs
z1 z2 z3 z4 Detection zone sets
1 0 1 0 Zone set 1
0 1 0 1 Zone set 2
1 0 0 1 Zone set 3
0 1 1 0 Zone set 4
Active no. of inputs = 2
+24VDC
OS32C
z1
z2
z3
z4
Number of Inputs
z1 z2 z3 z4 Detection zone sets
1 1 0 0 Zone set 1
1 0 1 0 Zone set 2
1 0 0 1 Zone set 3
0 1 1 0 Zone set 4
0 1 0 1 Zone set 5
0 0 1 1 Zone set 6
Active no. of inputs = 2

Fig. 2-6 Four-Zone Set Application

The above examples illustrate two different wiring schemes that use four inputs with two active required. The example on the left is configured for a four-zone set application. The example on the right is configured for a six-zone set application.

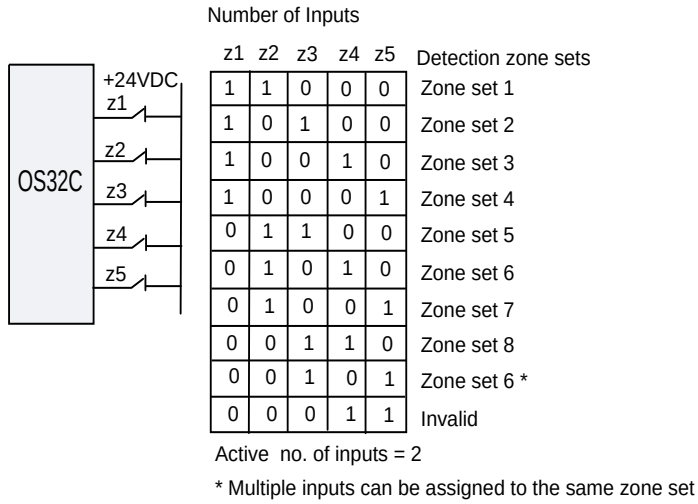
Number of Inputs
z1 z2 z3 z4 z5 Detection zone sets
+24VDC
OS32C
z1
z2
z3
z4
z5
1 1 0 0 0 Zone set 1
1 0 1 0 0 Zone set 2
1 0 0 1 0 Zone set 3
1 0 0 0 1 Zone set 4
0 1 1 0 0 Zone set 5
0 1 0 1 0 Zone set 6
0 1 0 0 1 Zone set 7
0 0 1 1 0 Zone set 8
0 0 1 0 1 Zone set 6 *
0 0 0 1 1 Invalid
Active no. of inputs = 2
* Multiple inputs can be assigned to the same zone set

Fig. 2-7 Eight-Zone Set Application

This example illustrates a wiring scheme that uses five inputs with two active required. This is used for an eight-zone set application.

Zone Set Switching

■ Introduction to zone set switching

As an example, examine a system configured to use 4 inputs with 2 of them active according to the following table:

		Zone Set Select Inputs			
		Z1	Z2	Z3	Z4
Zone Sets	Zone set 1	LOW	HIGH	HIGH	LOW
	Zone set 2	HIGH	LOW	LOW	HIGH

The following figure represents a transition from ZONE 1 to ZONE 2:

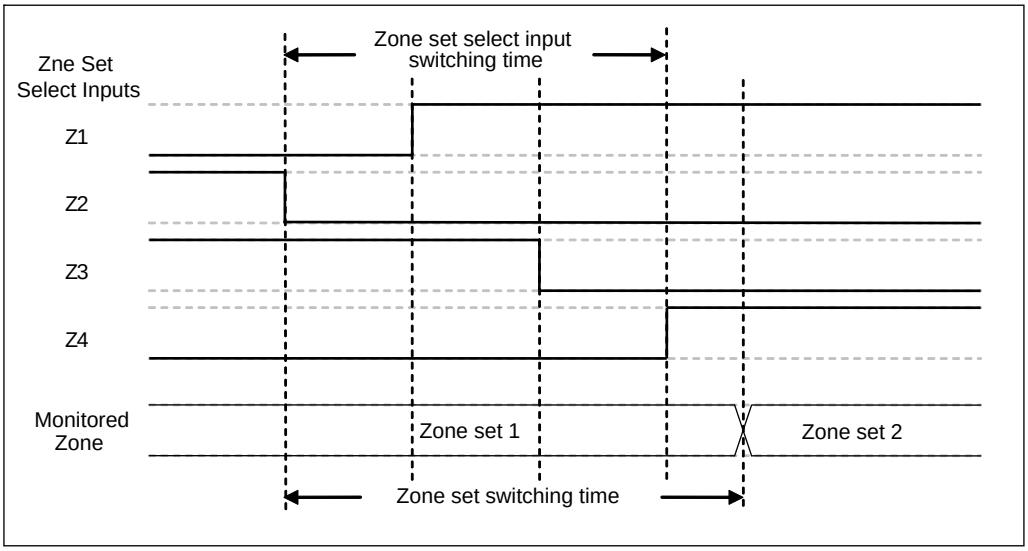

Fig. 2-8 Zone Switching example

⚠ WARNING

If the external zone switching device momentarily exceeds the configured number of active zone set select inputs during the zone switch, an additional Zone Delay may be incurred in the event that wiring of a zone set select input fails. The external zone switching device must properly sequence so the configured number of active inputs is not exceeded in order to guarantee that failed zone set select input wiring will be detected within the normal Zone Switching Time described below.

Let's consider an example Zone set A to Zone set B switching, where A represents any origin zone set number and B represents any destination zone set number.

When switching zone sets, there are three installation dependent parameters:

1) Zone Set Switching Timing - When switching from Zone set A, there is a point in time when protection of that zone set is no longer required, this point will be defined as $t_{EndZoneA}$. When transitioning to Zone set B, there is a point in time when the OSSDs must turn OFF if an object is present in Zone set B, this point will be defined as $t_{DangerZoneB}$. In order to ensure, $t_{DangerZoneB}$ is met, monitoring of Zone set B must start at least one response time ($T_{response}$) prior to $t_{DangerZoneB}$. The time at which monitoring of Zone set B must start will be defined as $t_{StartZoneB}$, where

$$t_{StartZoneB} = t_{DangerZoneB} - T_{response}$$

2) Zone Set Select Input Switch Timing - The worst case time it can take for switching zone set select inputs. This time starts on the transition on the first input change and ends to the transition on the last input change, this will be defined as $T_{switches}$.
3) Zone Set Select Input Switch Tolerance - It is required that the zone set select input switching circuitry begin switching the zone set inputs at a precise time relative to when the zone set transition is desired to occur. The tolerance of timing when input state is actually switched, generated by input switching circuitry, will be defined using +/- T_{tol}.

The simplest monitoring zone set switching timing in an installation is $t_{EndZoneA} < t_{StartZoneB}$. In this case, the interval between $t_{EndZoneA}$ and $t_{EndZoneA}$ does not require any monitoring, thus switching from zone set A to zone set B is straightforward. But when $t_{EndZoneA} = t_{StartZoneB}$ or $t_{EndZoneA} > t_{StartZoneB}$, both zone set A and zone set B may need to be monitored simultaneously. In such case, refer to How to Guarantee Protection of Original Zone Set.

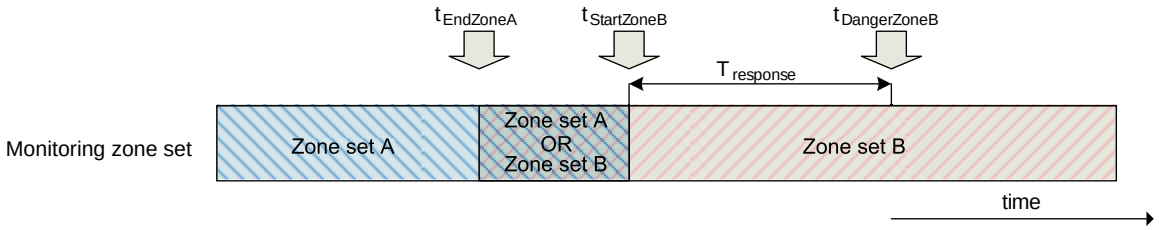

Fig. 2-9 Switch from Zone set A to Zone set B.

The Zone Set Input Switch Timing must be configured to consider delay time of input switching circuitry and ensure proper monitoring and safety. The configuration parameter Zone Set Switching Delay (T_{delay}) needs a value larger than $T_{switches}$ in increments of 20 ms (T_{sample}). In the following example, T_{delay} is configured to 80ms or more.

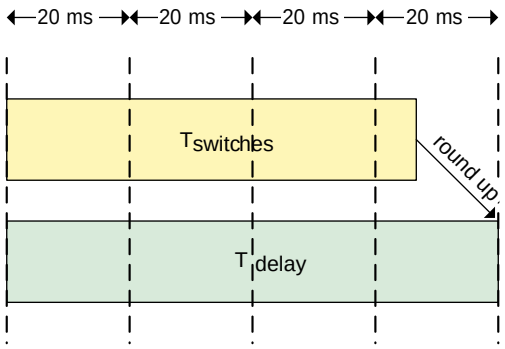

Fig. 2-10 Zone Delay configuration.

⚠ WARNING

If an insufficient Zone Delay is used for the actual worst case zone set select input switching time of the installation, an unintended zone set may be temporarily enabled, resulting in temporarily monitoring the wrong zone.

Also, it must be ensured that after a zone switch there is a minimum "hold time" before the next zone switch can take place. That time is 2 * T_{sample}.

The Zone Input Switch Tolerance(T_{tol}) is the tolerance on when the zone switching circuitry is actually able to start the switching of the inputs.

Besides T_{tol} and T_{delay}, there is an additional delay of up to T_{sample} before the change on the zone set select inputs is recognized.

Therefore, assuming switching of the inputs starts at t_{start}, the system is guaranteed to switch zones between $t_{min} = t_{start} + T_{delay} - T_{tol}$ and $t_{max} = t_{start} + T_{delay} + T_{tol} + T_{sample}$.

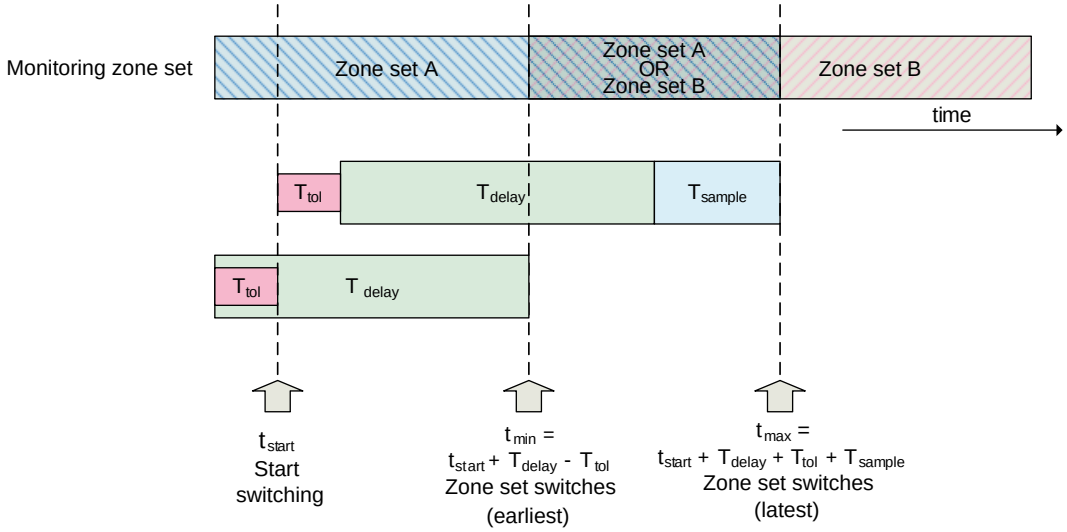

Fig. 2-11 Zone set select input switching and zone set switch.

■ How To Configure Input Switch Circuitry Timing

Relative to t_{start}, the longest time it will take to begin monitoring Zone set B is t_{max}. When you take into account the scanner's response time required to actually detect an object present in Zone set B, the longest time to turning off the OSSDs relative to t_{start} can be shown as:

$$t_{maxToOff} = t_{max} + T_{response}$$

The critical timing guarantee to be met when changing zone sets is $t_{DangerZoneB}$. The input switching circuitry should begin switching the zone set select inputs prior to $t_{DangerZoneB}$ to ensure Zone B is activated early enough to detect an object previously present in the zone set. The amount of time prior to $t_{DangerZoneB}$ to start switching can be derived from $t_{maxToOff}$ by equating it to $t_{DangerZoneB}$.

$$t_{start} = t_{DangerZoneB} - (T_{response} + T_{delay} + T_{tol} + T_{sample})$$

This means the switching circuitry must be configured to begin switching the inputs $T_{maxReaction}$ before $t_{DangerZoneB}$ to ensure safe monitoring of Zone set B, where

$$T_{maxReaction} = T_{response} + T_{delay} + T_{tol} + T_{sample}$$

⚠ WARNING

If t_{start} is configured without consideration of $T_{maxReaction}$, object detection within the new safety zone after switching and turning OFF of the safety outputs may be delayed.

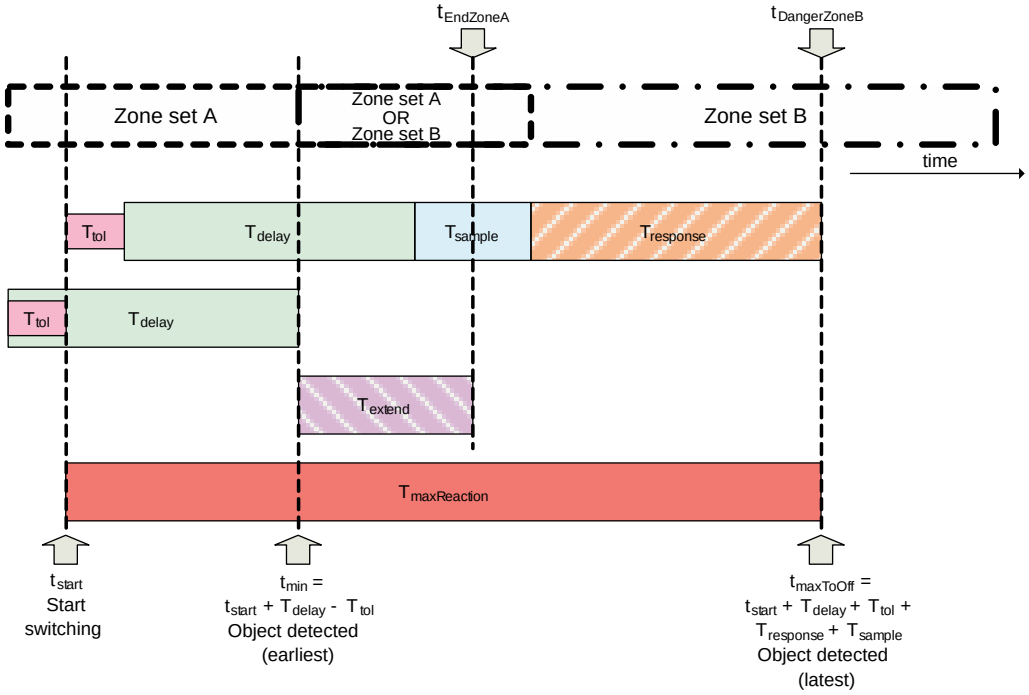

Fig. 2-12 Object detection in Zone set B.

From the diagram, there is a period of time, T_{extend}. Between t_{min} and $t_{EndZoneA}$, where the system may have switched to Zone set B already but it needs to protect Zone set A. This is covered in the following section.

■ How to Guarantee Protection of Original Zone Set

Additional measures may be necessary to ensure that Zone set A maintains adequate monitoring up to $t_{EndZoneA}$.

With t_{start} established relative to $t_{DangerZoneB}$, we must compare $t_{EndZoneA}$ and t_{min}.

Case 1. Zone set switching after the monitoring of zone set A is no longer required ($t_{EndZoneA} \leq t_{min}$)

When $t_{EndZoneA} \leq t_{min}$, no further modifications are necessary. Zone set A will be properly monitored for the duration that is needed.

Case 2. Zone set may be switched before the monitoring of zone set A is no longer required ($t_{EndZoneA} > t_{min}$)

When $t_{EndZoneA} > t_{min}$, measures must be taken to ensure that Zone set A is protected even when the monitoring zone is switched to zone set B before $t_{EndZoneA}$. A simple measure is to modify safety distance (S) used when defining Zone set A such that it includes an additional component (Z_{extra}) defined by the maximum approach speed (K) and a worst case extension time (T_{extend}) to account for the time that Zone set A may not be monitored.

$$Z_{extra} = K * T_{extend} = K * (t_{EndZoneA} - t_{min})$$

Expanding monitoring zone using this additional parameter Z_{extra} enables the OS32C to detect an object in advance that may enter the actual monitoring zone of zone set A during zone set switching. In other words, expanding the monitoring zone means that the timing of $t_{EndZoneA}$ is shifted to t_{min}.

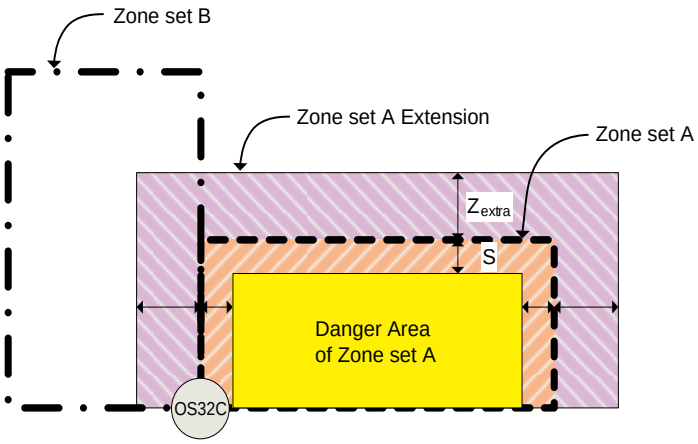

Fig. 2-13 Zone A extension.

The extension of the safety distance around the entire protection zone will guarantee the safe operation of the scanner. However, most installations may benefit from using the smallest possible monitoring zone perimeter to maximize usable work space. For other measures, refer to Additional Zone Set Switching Strategies on page 120.

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Getting Started

The configuration and installation of an OS32C is a simple process. Here are the basic steps needed to get started. Refer to the appropriate section of Chapter 3 for more information on any of these steps.

- Install the configuration tool
- Connect the OS32C to the same network as the computer
- Start the configuration tool
- Discover scanners on the network
- Log on to the OS32C
  - Select Access Level
  - Enter password
- Create new configuration
  - Safety-critical parameters (EDM, response time, operating mode, zone sets, etc.)
  - Non-safety-critical parameters (auxiliary output, warning output, power consumption mode, etc)
  - Zone configuration
- Send configuration to the OS32C

Installing Configuration Software

Installation of the configuration software for the OS32C requires the following:

- Pentium 4 class 1.5GHz CPU or equivalent
- Windows 2000, Windows XP, or Windows Vista
- 512MB of RAM
- 10MB of available hard disk space
- Monitor with resolution of 1024 x 768 pixels or better.

Install the software based on the following steps:

1. Terminate all applications running.
2. Insert CD-ROM of the configuration software to your CD drive.
3. Double-click the CD-ROM icon in My Computer to run Setup.exe.
4. Follow instructions of the installer program.
5. A program icon appears where you specified during installation.

To install the configuration software on Windows 2000, Windows XP Professional, or Windows Vista, a user account of supervisory access level (Administrators) is required.

How to Start

Select **Start**, **All Programs**, **OS32C Configuration Tool**, and **OS32C Configuration Tool** (if you have not changed the program folder name).

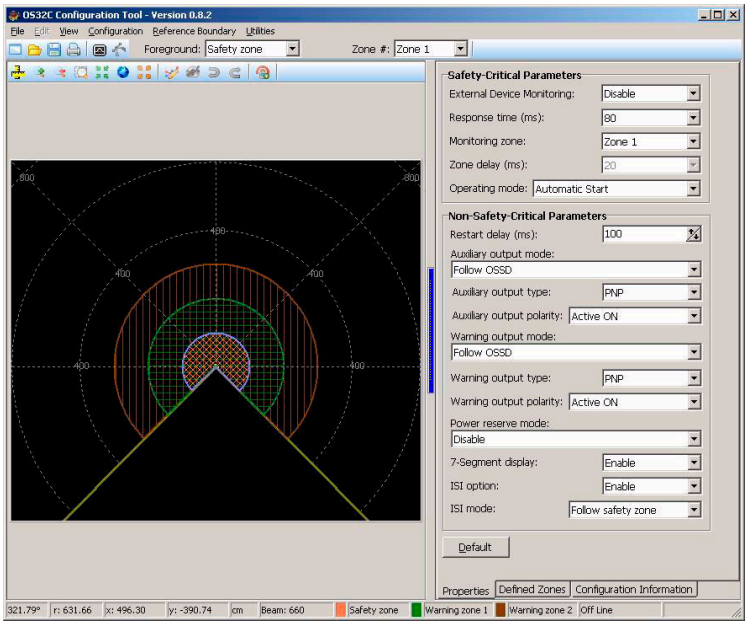


Fig. 3-1 OS32C Configuration Tool

Description of Screen

The configuration software consists of the following:

Menu

File

New	Used to create new configuration of OS32C
Open	Opens a configuration information file saved on PC
Save	Saves created configuration information on PC, or overwrites the existing configuration file if it was edited
Save As	Saves created configuration information on PC
Print Configuration	Prints OS32C configuration information
Print Screen Snapshot	Prints the zone information screen only with current window zoom
Exit	Terminates the configuration software

Table 3-1

Edit

Undo		Undo last action
Redo		Redo last action
Delete Selected Points		Delete selected point(s) (Applies to polygon shaped zone)
Select a Group of Points		Select a group of points (Applies to polygon shaped zone)
Convert Shape to	Circular Segment	Convert zone being edited to a circular segment
	Polygon	Convert zone being edited to a polygon

Table 3-2

View

Tool Bar	Main Tool Bar	Shows or hides the Main Tool Bar
	Edit Tool Bar	Shows or hides the Edit Tool Bar
Status Bar		Shows or hides the status bar
View All		Shows the zone information screen with minimum zoom
View Center		Shows the zone information screen with OS32C in the center
Zoom In		Magnifies the zone information screen
Zoom Out		Minimizes the zone information screen
Zoom Window		Magnifies a specified range of the zone information screen
Show/Hide Warning Zone 1		Shows or hides warning zone 1 in the zone information screen
Show/Hide Warning Zone 2		Shows or hides warning zone 2 in the zone information screen
Polar Coordinate		View the monitoring zone using the polar coordinate system
Cartesian Coordinate		View the monitoring zone using the cartesian coordinate system
Show/Hide Grid		Shows or hides grid
Show/Hide Scale		Shows or hides the scaling
Toggle Measurement Unit		Switches unit of measure. (cm or inch)

Table 3-3

Configuration

Edit Properties		Shows the configuration properties screen
Edit Zone		Switches to the monitoring zone configuration mode
Add Zone		Add a new zone to the configuration
Sculpting		Enable/Disable sculpting mode
Receive from Sensor		Receives current configuration information from the OS32C
Send to Sensor /Enter CFG Mode	All Changes	Sends only the changed item(s) to OS32C for registration
	Selected Items	Sends only the specified item(s) to OS32C for registration
	Entire Configuration	Sends all setup items to OS32C for registration

Table 3-4

Reference Boundary Monitoring

Disable Setting	Disable reference boundary monitoring for the selected zone.
Set Point as Reference Boundary	Set selected point(s) as reference boundary monitoring points.
Set Point as Non-reference Boundary	Un-set the selected point(s) as reference boundary monitoring point(s).
Set All as Reference Boundary	Set all points in the zone for reference boundary monitoring.
Set All as Non-reference Boundary	Set none of the points in the zone for reference boundary monitoring.
Set Zone Tolerance	Set the reference boundary monitoring tolerance for a zone.
Save Reference Boundary Setting	Apply reference boundary monitoring settings to the zone.

Table 3-5

Utilities

Discover Sensors		Find sensors on the network
Log On		Used to log on to the OS32C
Log Off		Used to log off from the OS32C
Change Sensor Name		Change the name of the OS32C
Sensor Ethernet Configuration		Change the IP address of the OS32C
Change Password		Used to change the password
Read Encrypted Password		Shows the encrypted password in case of lost password
Read Fault Log	Sensor	Displays the fault log of the sensor block
	I/O Block	Display the fault log of the I/O block
System Information		Display the system and ethernet configuration of the OS32C
Window Calibration		Used after the window is replaced
System Monitoring		Shows current OS32C scanning zone information on the zone information screen in real-time
Options		Change configuration software options

Table 3-6

Tool Bars

Fig. 3-2

(1)	Create a new configuration	Used to create new configuration of OS32C
(2)	Open configuration from file	Opens a configuration information file saved on PC
(3)	Save configuration to file	Saves created configuration information on PC
(4)	Print configuration	Prints OS32C configuration information
(5)	System Monitoring	Shows current scanning zone information on the zone information screen in real-time
(6)	Sculpting	Enable/disable sculpting mode

Table 3-7

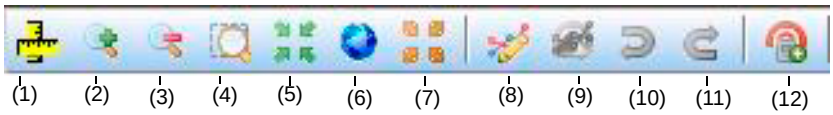


Fig. 3-3

(1)	Toggle measurement unit	Toggles unit of measure (inches or cm)
(2)	Zoom in	Magnifies the zone information screen
(3)	Zoom out	Minimizes the zone information screen
(4)	Zoom window	Magnifies a specific area of the zone information screen
(5)	View center	Shows the zone information screen with the OS32C in the center
(6)	View all	Shows the zone information screen with minimum zoom
(7)	Toggle view panning	Enables/Disables view panning (Allow a user to click on the displayed zone and move their mouse to adjust their view of the zone).
(8)	Edit zone	Enables/Disables the editing of zones
(9)	Convert shape to	Convert zone being edited to either a circular segment or a polygon
(10)	Undo	Undo last action
(11)	Redo	Redo last action
(12)	Add zone	Add a new zone to the configuration

Table 3-8

Information Bar

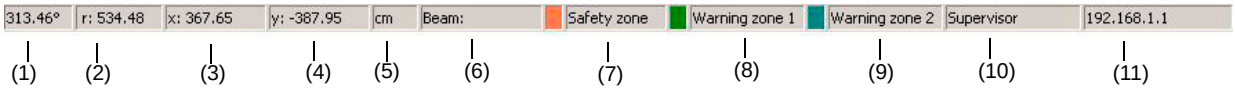


Fig. 3-4

(1)	Shows mouse position in polar coordinates (degrees)
(2)	Shows mouse position in polar coordinates (radius)
(3)	Shows mouse position in cartesian coordinates (x-axis)
(4)	Shows mouse position in cartesian coordinates (y-axis)
(5)	Shows unit of measure of mouse position
(6)	Shows beam number of the mouse position
(7)	Shows color of safety zone in the zone information screen
(8)	Shows color of warning zone 1 in the zone information screen
(9)	Shows color of warning zone 2 in the zone information screen
(10)	Shows current logon access level
(11)	When connected to an OS32C, displays the IP Address of the OS32C

Table 3-9

Offline Mode

In offline mode, a user can create, configure, and save a configuration to the PC, as well as load and edit existing configurations on the PC. To enter offline mode, follow the steps shown below:

1. After the configuration software is launched, the window shown below is displayed.
2. Click **Cancel**.
3. The configuration software is launched in offline mode.

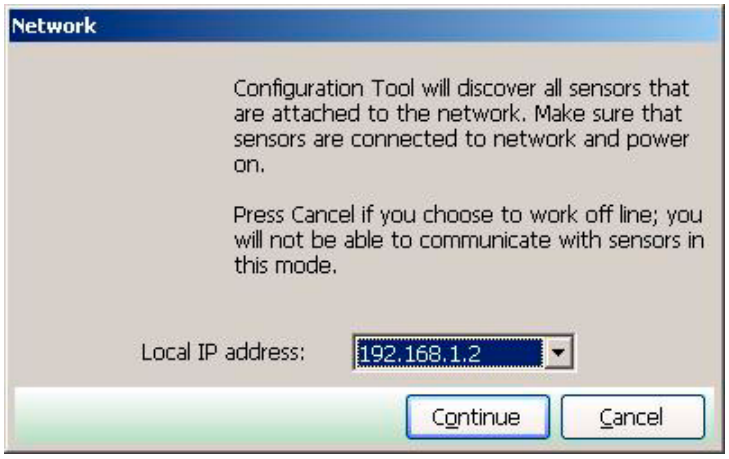

Network
Configuration Tool will discover all sensors that are attached to the network. Make sure that sensors are connected to network and power on.
Press Cancel if you choose to work off line; you will not be able to communicate with sensors in this mode.
Local IP address:
192.168.1.2
Continue
Cancel

Fig. 3-5 Offine Configuration

Connection to the OS32C

This section describes how to connect a PC with the configuration software and the OS32C.
The configuration software is connected to the OS32C via Ethernet. An Ethernet cable with an M12, 4-pin connector is required.

See page 93 for more details.

The default Ethernet configuration of the OS32C is DHCP mode (configuration to automatically obtain an IP address).
When connecting a PC to the OS32C, different types of connections are available depending on the user's environment. See the following examples according to your connection environment.

Connecting the PC and the OS32C

1. Physically connect the OS32C to the PC.
   - For a direct connection, use an Ethernet cable to connect the OS32C directly to the Ethernet port of the PC.

     -- or --

   - Use an Ethernet cable to connect the OS32C to the local area network of the PC.

CHECK!
On a network that limits the connection by MAC address authentication, etc., modify the settings to allow the OS32C to connect to the network.

2. Configure the Ethernet settings of the PC and the OS32C so that they can communicate with each other. There are two ways to do this:
   - Configure both the PC and the OS32C to DHCP mode.

     Set both the PC and the scanner to DHCP mode (both devices are set to obtain an IP address automatically). If no DHCP server is present on the network, it will take approximately 40 seconds to establish the connection after connecting the PC to the OS32C. While the connection is being established, the Local Area Connection icon on the system tray will look like this:

Fig. 3-6 Connecting Icon

The configuration tool will not be able to connect to the OS32C while this icon is displayed.

A Limited Connection icon will be displayed after the connection icon on the system tray disappears. The configuration tool will now be able to connect to the OS32C.

Fig. 3-7 Limited Connectivity

-- or --

   - Configure both the PC and the OS32C to different fixed IP addresses on the same network.

A PC can be connected to the OS32C by configuring the PC to a different fixed IP address within the same network as the IP address of the OS32C.

- Keep in mind that every time a change is made to the scanner, a reset of the scanner will be required, which means the connection session between PC and scanner will have to be re-established.
- Consider the amount of time required for a reset of the OS32C when deciding which Ethernet settings to use for the PC and the OS32C. When both PC and OS32C are set to DHCP mode, the time required for resetting the scanner and re-establishing the ethernet connection between the two devices can be up to 55 seconds. When both PC and OS32C are configured with fixed IP addresses, the time required for resetting the scanner and re-establishing the ethernet connection can be up to 15 seconds.
- When a device with the same IP address as the OS32C exists, a connection failure may occur. Be careful not to have any duplicate IP addresses when connecting multiple OS32Cs to the network.

Forced DHCP mode

The OS32C can be temporarily forced into DHCP mode upon startup, regardless of the Ethernet configuration settings of the OS32C.

1. Connect a PC directly to the scanner.
2. Power cycle the OS32C and then press and hold the Start button upon startup.
3. If the Start input is detected upon startup, the LEDs start blinking (this particular blinking does not happen with a normal startup).
4. Once the blinking starts, release the Start button before 5 seconds have elapsed. If the release occurs before 5 seconds, the OS32C enters forced DHCP mode.
5. Disconnect and reconnect the Ethernet cable to start automatic IP address acquisition.
6. Using the forced DHCP mode connects the PC with the DHCP mode and OS32C with the fixed IP address setting.

As forced DHCP mode is a temporary mode, power cycle the OS32C to return the scanner to its fixed IP address.

Changing the IP address of the PC (Windows 2000)

1. Log on to the computer as the Administrator.
2. Click the **Start** button, click **Settings**, then click **Control Panel**.
3. Double-click **Network and Dial-up Connections**.
4. Right-click the local area connection to be changed, then click **Properties**.
5. In the **Components checked are used by this connection** box, select **Internet Protocol (TCP/IP)**, then click **Properties**.
6. To set the PC to DHCP mode, select **Obtain an IP Address automatically**.
   To set the PC to a fixed IP address, select **Use the following IP address** and specify the desired IP address.

Changing the IP address of the PC (Windows XP)

1. From the **Control Panel**, open **Network Connections**.
2. Right-click the Local Area Connection and select **Properties**.
3. Scroll-down and select **Internet Protocol (TCP/IP)**.

4. With **Internet Protocol (TCP/IP)** highlighted, click Properties.

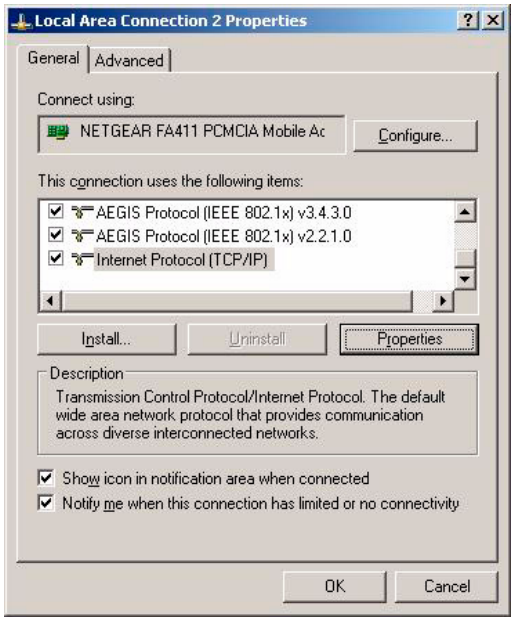


Fig. 3-8 Local Area Connection Properties

5. To set the PC to DHCP mode, select **Obtain an IP Address automatically**.
To set the PC to a fixed IP address, select **Use the following IP address** and specify the desired IP address.

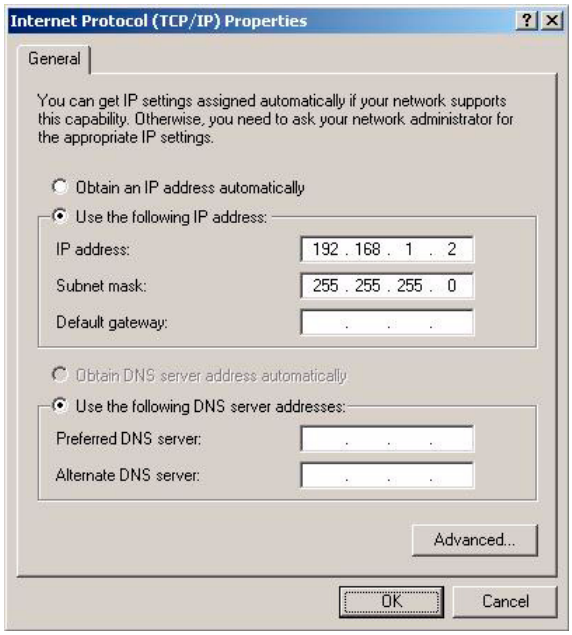

Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
192 . 168 . 1 . 2
Subnet mask:
255 . 255 . 255 . 0
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Advanced...
OK
Cancel

Fig. 3-9 TCP/IP Properties

6. When selecting **Obtain DNS server address automatically**, an alternate configuration can be set. To set a fixed IP address for the alternate configuration, select **Use the following IP address** from the

Alternate Configuration tab. Set an IP address correctly according to the network environment. If you do not set the IP address, select **Automatic private IP address**.

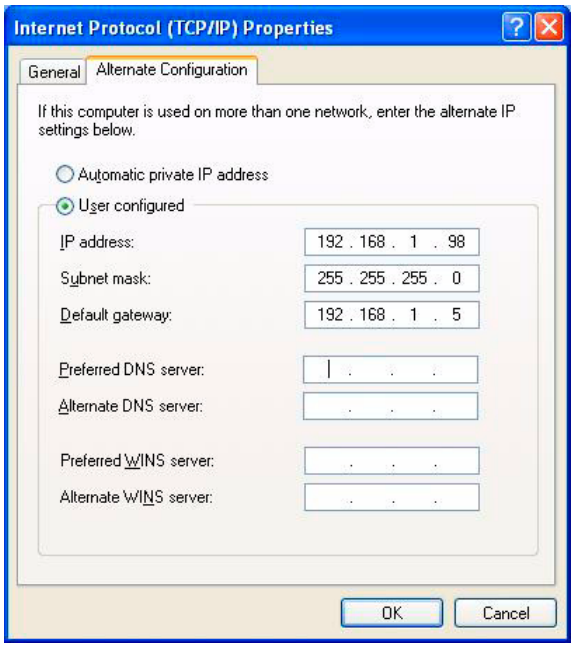


Fig. 3-10 Alternate Configuration

Changing the IP address of the PC (Windows Vista)

1. Click the Start button, then click **Control Panel**.
2. Click **Network and Internet**.
3. Click **Network and Sharing Center**.
4. Click **Manage network connections**.
5. Right-click on the connection to be changed, and select **Properties**. If prompted for an administrator password, enter the password and confirm.
6. Select the **Networking** tab.
7. Select Internet **Protocol Version 4 (TCP/IPv4)** and then click **Properties**.
8. To set the PC to DHCP mode, select **Obtain and IP Address automatically**.
   To set the PC to a fixed IP address, select **Use the following IP address** and specify the desired IP address.

Logging on to the OS32C

There are 2 types of access levels:

• Operator Access Level (Operator)
To log on to the configuration software with this access level, a password is not required. This access level cannot make changes to OS32C configurations. Only verification and monitoring of existing configuration is available.

• Supervisory Access Level (Supervisor)
To log on to the configuration software with this access level, a password is required. This access level allows a user to check, change and monitor OS32C configuration information.

Detecting the OC32C on the network

To connect to the OC32C using the configuration software, the user needs to find the IP address of the OS32C on the network. Select **Discover Sensors** from the **Utilities** menu.

Since the configuration software is connected to the OS32C via Ethernet, Windows Security Alert is displayed when Windows firewall is activated. Select **Unblock**. The alert will not be displayed once it is unblocked.

Windows Security Alert
To help protect your computer, Windows Firewall has blocked some features of this program.
Do you want to keep blocking this program?
Name: OS32C_CFGTool
Publisher: Unknown
Keep Blocking
Unblock
Ask Me Later
Windows Firewall has blocked this program from accepting connections from the Internet or a network. If you recognize the program or trust the publisher, you can unblock it. When should I unblock a program?

Fig. 3-11 Windows Security Alert

Logging On

1. From **Utilities** menu, select **Log On**.
2. The Log On screen is displayed. Select an IP address of the OS32C to be connected.

Fig. 3-12 Logging On

3. Select **User access level** and enter a password. The initial password of the supervisor is "supeusr".
4. Click **Continue**.
5. When connected, the IP address and User access level of the OS32C are displayed.

Fig. 3-13 Logged On to Sensor

Logging OFF

From the **Utilities** menu, select **Log OFF** and click **OK**.

Changing Password

To limit access by an unauthorized user, the password may be changed. The user needs to log on to the OS32C with the supervisory access level, to change the password. The following steps describe this process:

1. Log on to OS32C with the supervisory access level.
2. From the **Utilities** menu, select **Change Password**.
3. Enter the current password.
4. From **Change Password**, select an access level you want to change.
5. Enter the new password.
6. Enter the new password again for confirmation.
7. Click **Change Password**.
8. A confirmation message is displayed. Click **Yes** to change the password.

Fig. 3-14 Change User Password

CHECK!

The password must contain at least 4 but no more than 7 alphanumeric characters. The password is case-sensitive.

Forgot the Password?

If the password has been lost/forgotten, follow the steps shown below to acquire the password. This procedure must be executed under the operator access level.

1. Log on with the Operator access level.
2. From the **Utilities** menu, select **Read Encrypted Password**.
3. Select **Supervisor** and click **Read Password**.
4. The encrypted password is displayed on the screen.
5. Contact OMRON STI's sales representative with this character string.

Changing Ethernet Configuration of OS32C

1. From the **Utilities** menu, select **Ethernet Configuration**.
2. To configure the OS32C to DHCP mode, select **Obtain an IP Address automatically**. To configure the OS32C to a fixed IP address, select **Use the following IP address** to specify an IP address. Set an IP address correctly according to the network environment.

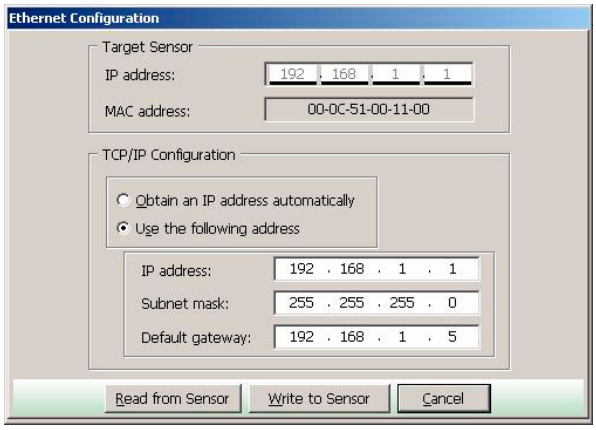


Fig. 3-15 Ethernet IP Address

3. Click **Write to Sensor**.
4. Confirm the change in Ethernet configuration. Click NO to abort the change.
5. The following window is displayed. Read the message and decide if you want to continue to use the current IP address or start using the new address now.

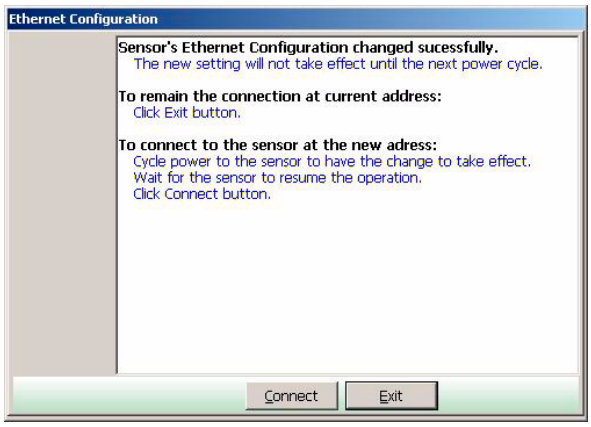

Ethernet Configuration
Sensor's Ethernet Configuration changed sucessfully.
The new setting will not take effect until the next power cycle.
To remain the connection at current address:
Click Exit button.
To connect to the sensor at the new adress:
Cycle power to the sensor to have the change to take effect.
Wait for the sensor to resume the operation.
Click Connect button.
Connect
Exit

Fig. 3-16 Ethernet Configuration

Receiving OS32C Configuration Information

The configuration software receives and displays current configuration information immediately upon connection to the OS32C. Configuration information can be received manually as well. From **Configuration** menu, click **Receive from Sensor**. Configuration information is retrieved from the sensor.

Configuring New OS32C Property and Monitoring Zone

⚠ WARNING

To use the protective function of OS32C, a safety zone must be properly defined and configured.

If the response time is changed, re-calculation of the safety distance is required. This may require re-configuration of the safety zones or re-installation of the OS32C. If the safety distance is not appropriate for the application, the machine may not stop before the hazardous area is reached, resulting in severe injuries.

This section describes how to configure a new monitoring zone or change the operating properties of the OS32C using the configuration software.

Default Configuration Settings

Safety Critical Parameters	
External Device Monitoring	Disable
Response time (ms)	80
Monitoring zone	Zone 1
Zone delay (ms)	20
Operating mode	Automatic Start
Non-Safety Critical Parameters	
Restart delay (ms)	400
Auxiliary output mode	Follow OSSD
Auxiliary output type	PNP
Auxiliary output polarity	Active ON
Warning output mode	Follow OSSD
Warning output type	PNP
Warning output polarity	Active ON
Power reserve mode	Disable
Seven-segment display	Enable
ISI option	Enable
ISI mode	Follow safety
Safety Zone	
Shape	Circular segment
Radius (cm)	100
Scan angle (degrees)	270
Warning zone 1	
Shape	Circular segment
Radius (cm)	200

Scan angle (degrees)	270
Warning zone 2	
Shape	Circular segment
Radius (cm)	300
Scan angle (degrees)	270

Table 3-10 Defalt Settings

Creating a New Configuration

To change the configuration of the OS32C, a user must log on to the OS32C with the supervisory access level.

1. From **File** menu, select **New**.
2. Enter a description for the configuration (up to 127 characters).

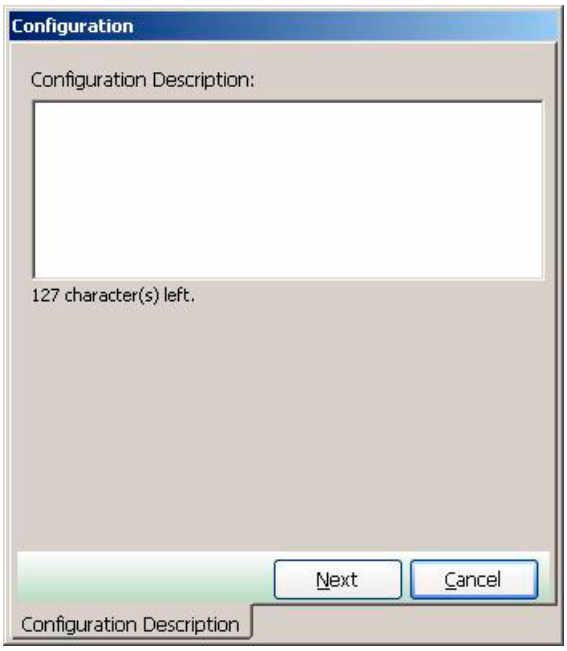


Fig. 3-17 Configuration Description

3. New configuration screen is displayed.

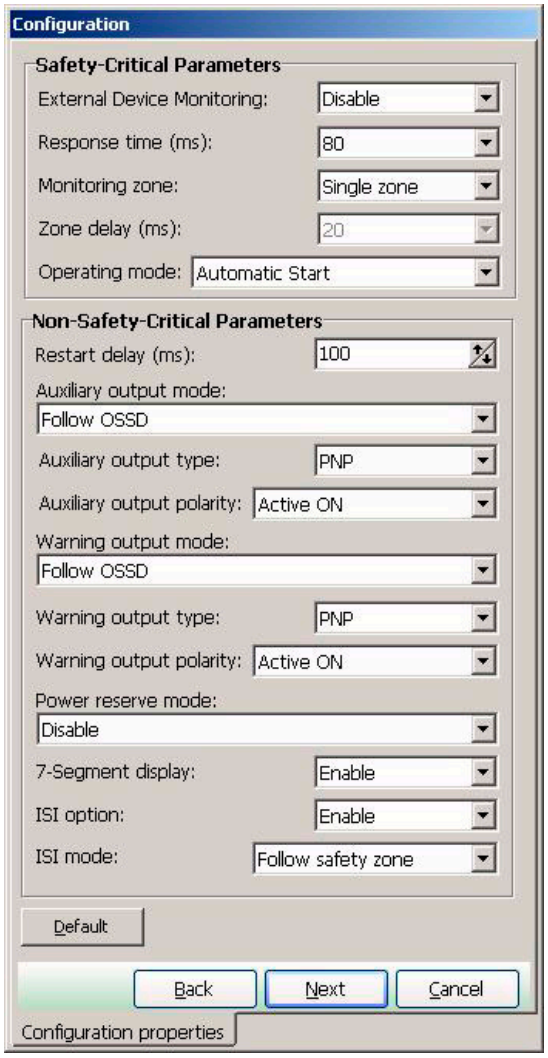


Fig. 3-18 New Configuration Parameters

• Safety Critical Parameters

1. External Device Monitoring (EDM) : When enabled the OS32C can monitor the N.C. contacts of the external control relays. These relays are controlled by the OSSD safety outputs.
2. Response Time : Configures a time period for OS32C safety output from ON to OFF. The available range is from 80ms to 680ms in increments of 40ms.
3. Monitoring Zone : To configure only one zone set, select **Single zone**. To configure more than one zone, select **Multiple zone**.
4. Zone Delay : Select the desired Zone Delay. The available range is 20ms to 320ms in increments of 20ms.
5. Operating Mode : A user can select from **Automatic Start**, **Start Interlock**, or **Start/Restart Interlock**.

• Non-Safety-Critical Parameters

1. Restart Delay : Select the desired OFF-to-ON delay when wiring the OS32C in Automatic Start. Available range is 100ms to 60s, in increments of 100ms.

2. Auxiliary Output Mode : Select either **Follow OSSD**, **Indicate FAULT**, **Warning Zone 1 infringed**, **Warning Zone 2 infringed**, or **Window contaminated**.
3. Auxiliary output type : Select **PNP** or **NPN**.
4. Auxiliary output polarity : Select **Active ON** or **Active OFF**.
5. Warning Output Mode : Select either **Follow OSSD**, **Indicate FAULT**, **Warning Zone 1 infringed**, **Warning Zone 2 infringed**, or **Window contaminated**.
6. Warning output type : Select **PNP** or **NPN**.
7. Warning output polarity : Select **Active ON** or **Active OFF**.
8. Power reserve mode : Select either **Disabled** or **Standby** mode.
9. Seven-segment display : Select **Enable** or **Disable**. The seven-segment display can be disabled to save power. Note: even if the seven-segment display is disabled, the 4-digit code for programming a scanner will still be displayed.
10. ISI option : Select **Enable** or **Disable**. When enabled, the ISIs will turn ON to indicate the sector(s) where an intrusion has occured in a safety or warning zone (depends on the ISI mode, see below).
11. ISI mode: Select **Follow safety zone** to have the ISIs light up to indicate the sectors where an intrusion has occurred in the safety zone. Select **Follow warning zone** to have the ISIs light up to indicate the sector(s) where an intrusion has occured in a warning zone.

4. After configuration of parameters is finished, click **Next**.

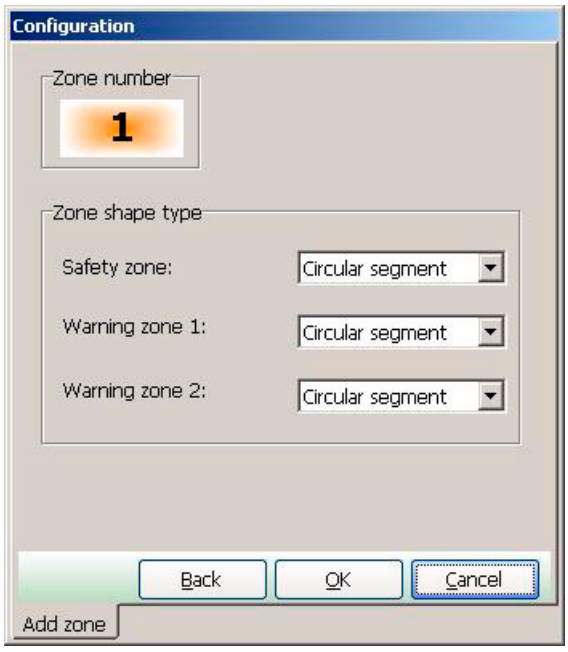


Fig. 3-19 Zone Shape

Zone Shape: Select either polygon or circular segment. Selecting a polygon automatically creates a shape with six segments. This shape can be changed after finishing the wizard.

5. Click **Next**. If **Multiple zones** is selected, proceed to select zone shapes for the other zone(s).

6. The screen shown below is displayed. (In this example, a polygon was selected for the safety zone, a polygon was selected for warning zone 1, and a circular segment was selected for warning zone 2).

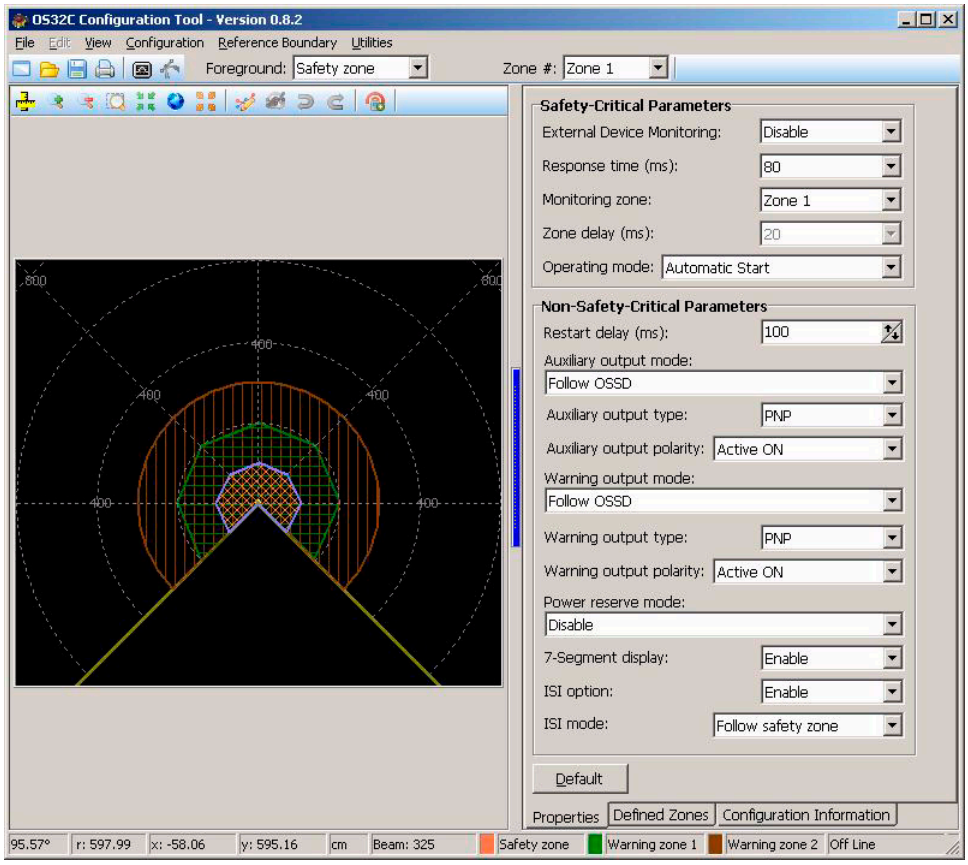


Fig. 3-20 Confirming Configuration

CHECK!

Safety and warning zones must be configured so that they are at least 100mm away from the wall.

Zone Set Selection and Configuration

Once the number of zone sets is defined, the configuration tool is used to program the OS32C. Zone sets can be added one at a time.

Add a Zone

1. Before adding a new zone, make sure **Multiple Zone** has been selected for the **Monitoring Zone** parameter.

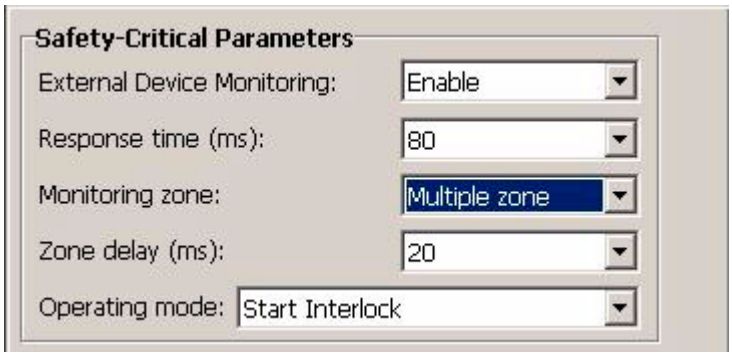


Fig. 3-21 Multi-zones

2. From the **Configuration** menu, select **Add Zone**.

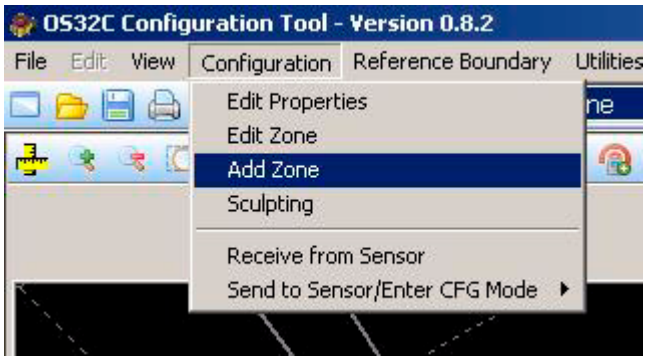


Fig. 3-22 Add Zone

3. Confirm the zone shapes for the new zone.

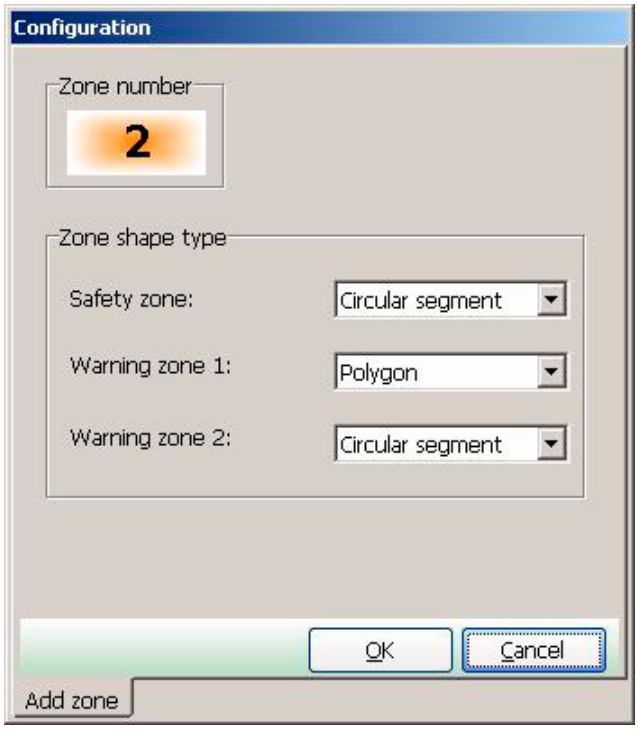


Fig. 3-23 Confirm Zone Shapes

Delete a Zone

1. On the **Defined Zones** tab, right-click on the zone to be deleted.
2. Select **Delete Zone**.

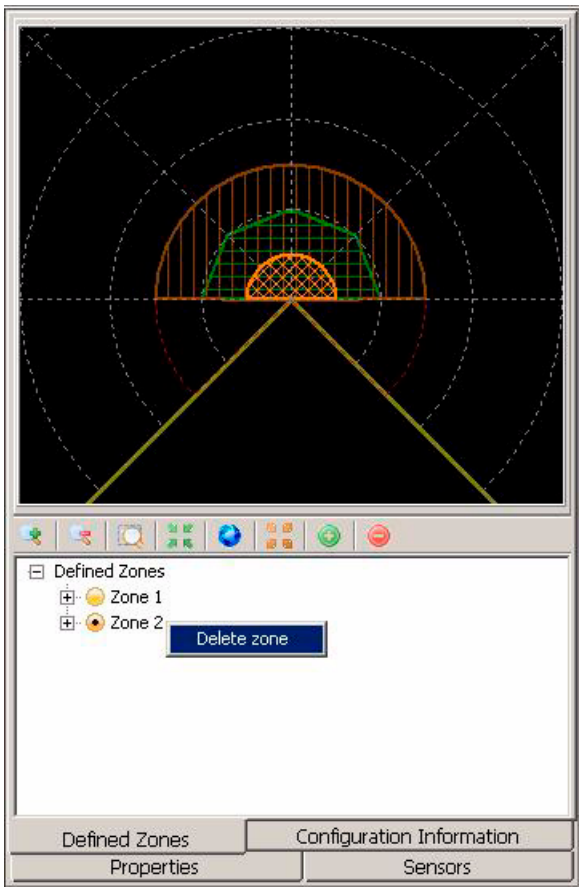


Fig. 3-24 Delete Zone

Zone Set Input Selection

Once you have determined the number of zone sets required for your application, you will need to determine the number of inputs you will use and the zone set select input states associated with each zone set. Fig. 3-25 illustrates the use of five inputs and how they apply to the five selected zones.

CHECK!

The combination of required inputs can be customized by the installer. This configuration uses the recommended **Default** combinations.

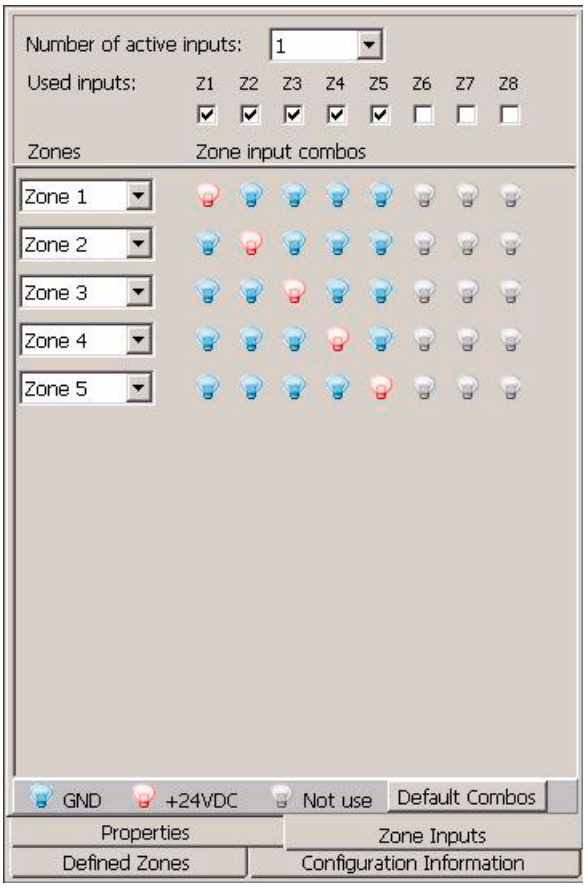


Fig. 3-25 Zone Set Select

Editing Properties

This section describes how to edit the properties of the OS32C such as response time and operating mode.

⚠ CAUTION

When transferring data from the PC to the OS32C and more than one OS32C is connected to the network, it is necessary to visually check the diagnostic code on the status/diagnostic display. It is recommended that the OS32C be installed in a position where the status/diagnostic display will be visible.

1. From **Configuration** menu, click **Edit Properties**.
2. A configuration properties screen is displayed.

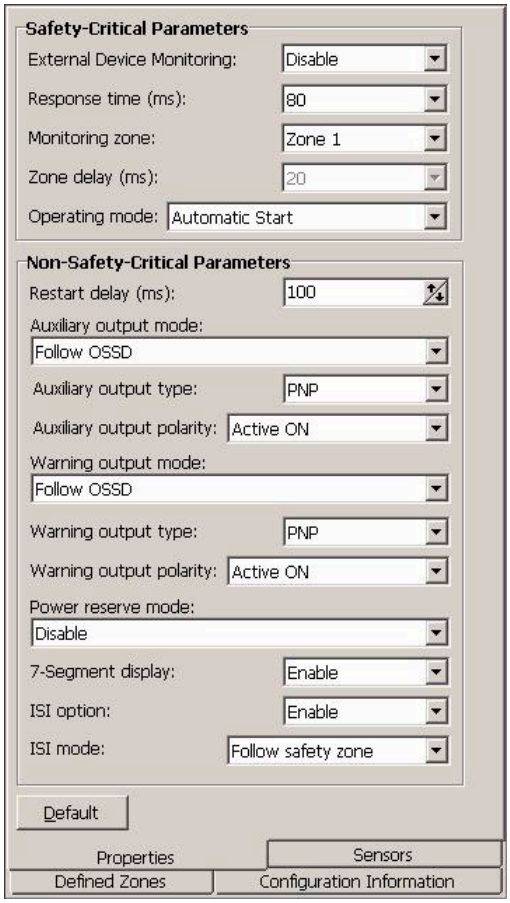


Fig. 3-26 Edit Properties

3. Edit the item to be changed.
4. After finishing the edits, from **Configuration** menu click **Send to Sensor/Enter CFG Mode**, **All Changes**.
5. The screen shown below is displayed. Click **Yes** to confirm.

Send configuration to sensor
The operation requested will result in the deactivation of the protected equipmentand the OS32C will enter the configuration mode.
Would you like to proceed?
Yes
No

Fig. 3-27 Save Configuration to Sensor

6. When the configuration tool detects multiple scanners on a network, the user will be prompted to enter a 4-digit code from the seven-segment display of the scanner being configured. The order in which each two-digit pair is entered does not matter.

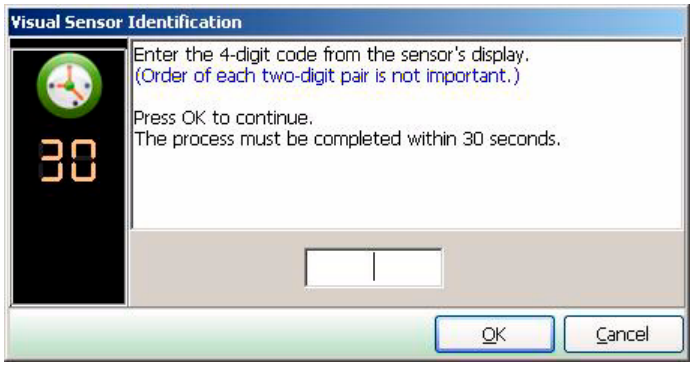

Visual Sensor Identification
Enter the 4-digit code from the sensor's display.
(Order of each two-digit pair is not important.)
Press OK to continue.
The process must be completed within 30 seconds.
30
OK
Cancel

Fig. 3-28 Visual Scanner Identification

When the configuration tool detects only one scanner on the network, the user will be prompted to confirm that the computer is connected to only one scanner. When this happens, the user will not need to enter the 4-digit Visual Sensor Identification code when making changes to the scanner.

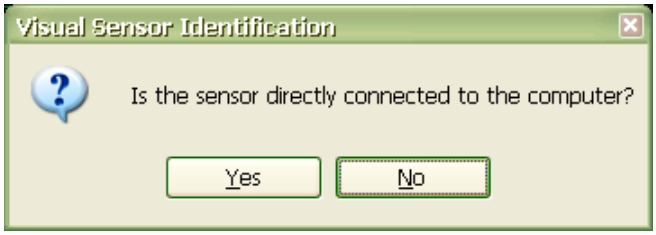


Fig. 3-29 Directly connected

7. A confirmation message is displayed for the changed item. Verify the message and click **Yes** to confirm.

8. A message shown below is displayed for confirmation of zone configuration edits. Clicking **Refresh Scan Zone** displays new scanning zone information of the OS32C on the screen. Click **Yes** to confirm the configured zone. If a configured zone has not changed, this message will not appear.

Fig. 3-30 Confirming Zone Configuration

9. After transmission is finished, the window shown below is displayed. Click **Yes** to confirm. If you do not want to register the configuration, click **No**.

Write Configuration
All changes were sent to the sensor.
Would you like to register your changes?
Selecting No will discard all changes.
Yes
No

Fig. 3-31 Write Configuration

10. The screen shown below is displayed while the OS32C resets.

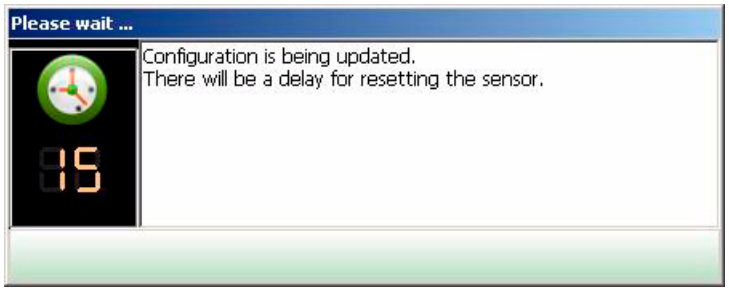


Fig. 3-32 Reset

The configuration is now complete.

CHECK! If writing cannot be done, wiring may be wrong. Refer to page 95 to correct wiring.

Editing Monitor Zones

This section describes how to edit and register the changes made to the zone configurations to the OS32C.

1. From **Configuration** menu, click **Edit Zones**.
2. From **Zone Set** of the tool bar, select a zone set to edit. Then select a zone to edit from **Foreground**. (In this example, Zone 2 and a Warning zone 2 are selected)

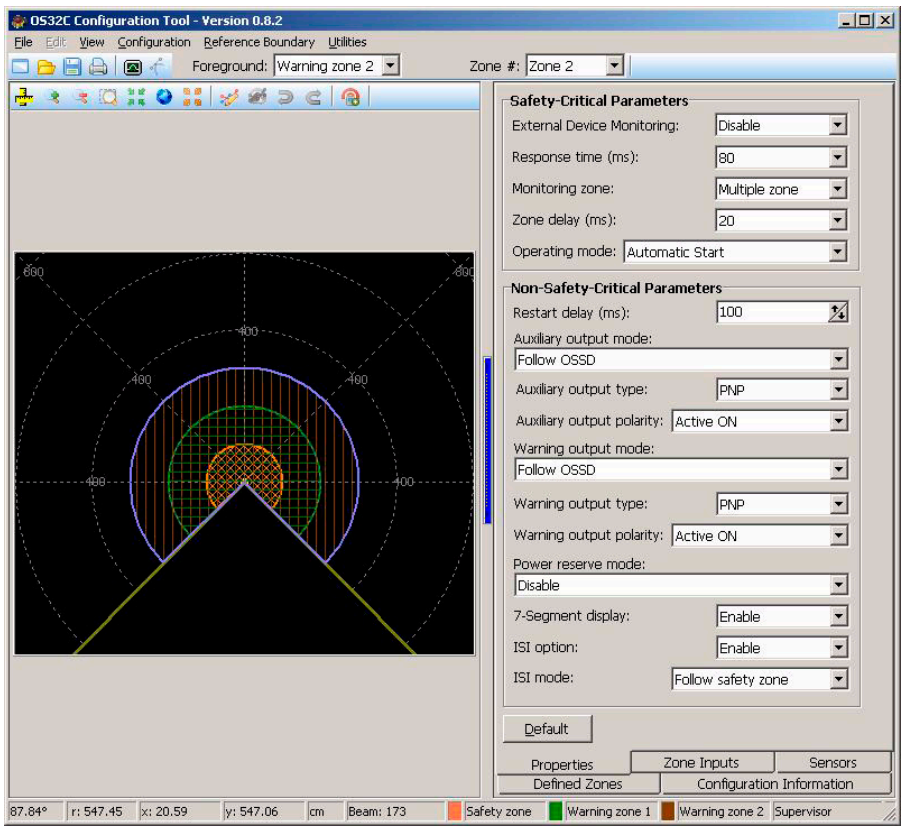


Fig. 3-33 Edit Zones

CHECK! When a scanner enters zone configuration mode, the zone scanned by the OS32C is displayed. If you do not want to display scanning zone information in the zone configuration mode, select **Options** from the **Utility** menu, and unselect **Shows scan zone in edit mode**.

3. A monitoring zone can be edited by:

a) Moving a point
Click a point of the circular segment, or polygon you want to move and drag it where you want to place it.

b) Changing a zone shape
From **Edit** menu, select **Convert Shape To**. Select the new shape

c) Sculpting
Sculpting & Reference Boundary Monitoring p.58

d) Changing the scan angle
To change the scan/detection angle of a zone:
1. Select the zone to be changed.

2. From the Configuration menu, select Edit Zone.
3. Adjust the scan angle by moving either of the outermost points of the zone. In each of the figures below, the two bottom-most points can be used to adjust the scan angle of the zone. The scan angel can be as small as 45 deg. or as large as 270 deg.

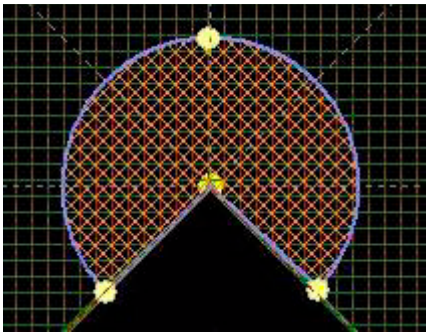


Fig. 3-34 CIrcular Segment

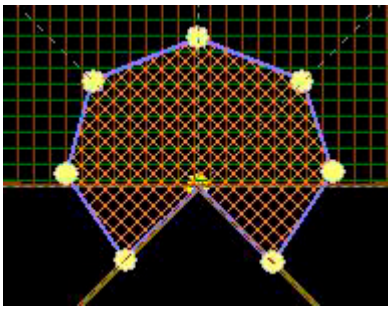


Fig. 3-35 Polygon Shape

For normal zones (polygon and sculpted shapes), the user can add or remove points from the zone shapes:

a) To add a point: double-click on the zone to add a point.

b) To add a point by specifying a coordinate:

i) Right-click on the zone and select **Creating a point by coordinate**

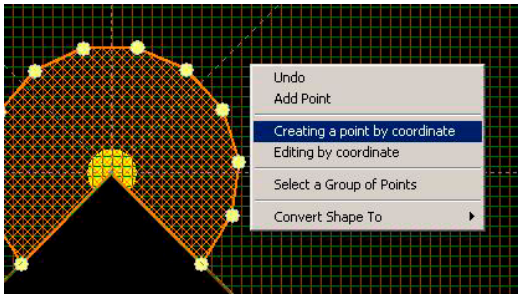


Fig. 3-36 Create a Point by Coordinate

ii) Specify the x-y coordinates for the location of the new point

Fig. 3-37 Specify x-y coordinates

iii) Click **OK**.

c) To change the location of a point by specifying a coordinate:

i) Right-click on the zone and select **Editing by coordinate**

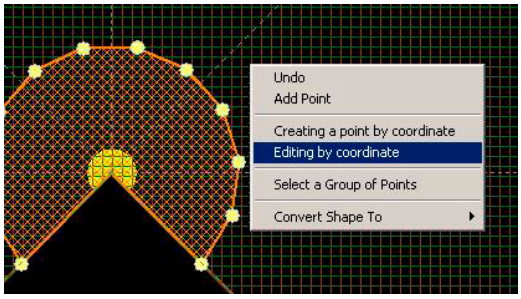


Fig. 3-38 Edit a Point by Coordinate

ii) Select the point to be modified by selecting the point number from the pull-down menu. The selected point will be circled.

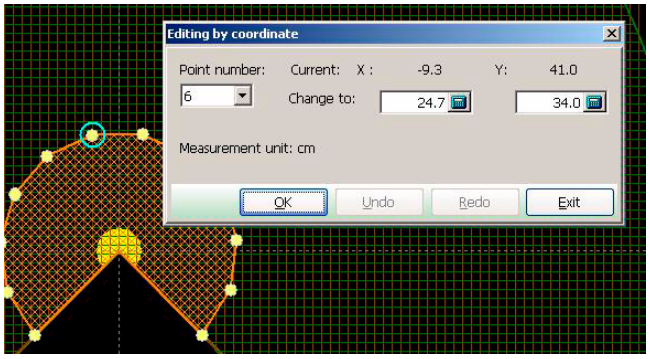


Fig. 3-39 Specify x-y Coordinate

iii) Specify the new desired x-y coordinates for the selected point.

iv) Click **OK**.

d) To remove points:

i) From the Edit menu select **Select a Group of Points**. (This menu can also be accessed by right-clicking on the zone).

ii) Use the mouse to select the desired point(s).

iii) From the **Edit** menu select **Delete Selected Points**.

4. When zone edit is finished, click **Edit Zones** from **Configuration** menu and verify if the checkbox is being unselected. Now zone configuration is complete.

5. Send the configured zone information to the OS32C for registration. From **Configuration** menu, click **Send to Sensor/Enter CFG Mode**, **All Changes**. Configure by following instructions on a displayed message.

6. Reset the OS32C by following the prompts.

Configuration is now complete.

CHECK! Safety and warning zones must be configured so that they maintain a distance of 100mm from the wall or fixtures.

Sculpting & Reference Boundary Monitoring

The scanning zone information from the OS32C can be used for zone configuration. The desired safety zone can be traced within the scanning range of the OS32C. Zone configuration based on this data is called sculpting.

To configure a zone with sculpting, follow the steps shown below.

1. From the **Configuration** menu, select **Sculpting**.
2. The sculpting data displayed on the screen is based on the scanning information sent from the OS32C. Move an object (such as a test piece) around the perimeter of the zone under configuration. The position where the object is detected closest to the OS32C is used as the sculpting data.

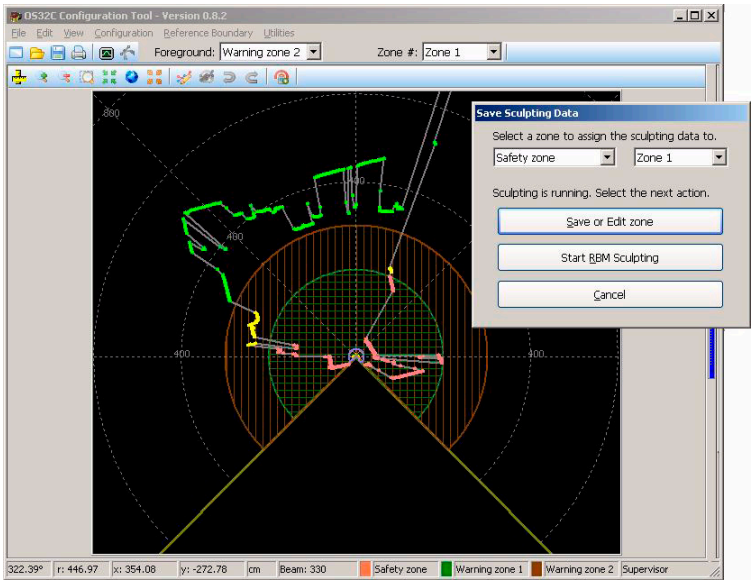


Fig. 3-40 Sculpting Mode

3. To redo the configuration, exit sculpting mode by clicking the **Cancel** button on the **Save Sculpting Data** window, and re-entering sculpting mode.

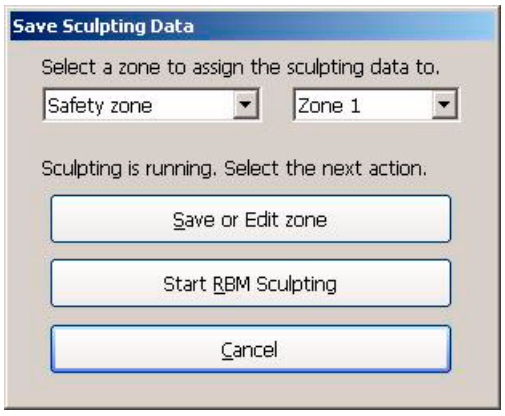


Fig. 3-41 Save Sculpting Data Window

4. If sculpting data displayed on the screen is correct, select the zone to which the configured sculpting data is to be assigned by using the pull-down menus in the **Save Sculpting Data** window. Click the **Save or Edit Zone** button.

5. To enable Reference Bounding Monitoring (RBM), select the desired zone for RBM and then click the **Start RBM Sculpting** button.

6. The scanner will then take approximately 50 seconds to measure the boundary. It is important not to change the boundary during this time since the scanner will be re-scanning the area and taking an average of the distances.

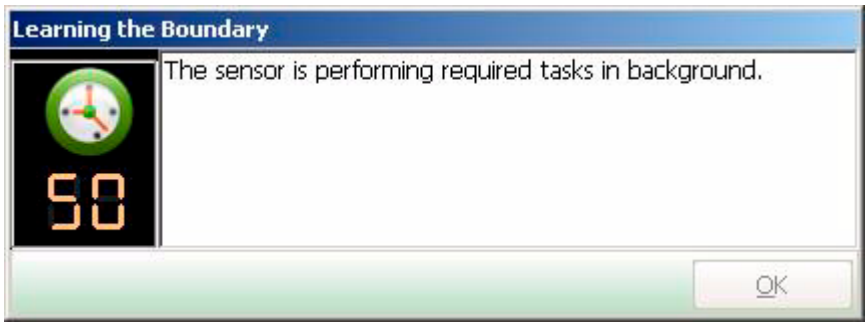


Fig. 3-42 Learning the Boundary

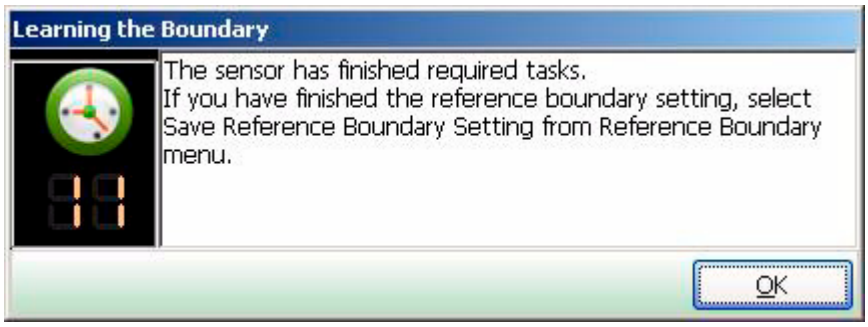

Learning the Boundary
The sensor has finished required tasks.
If you have finished the reference boundary setting, select Save Reference Boundary Setting from Reference Boundary menu.
OK

Fig. 3-43 Learning the Boundary Complete

7. Select the points to be used for RBM:

a. To select all the points in the zone for RBM

•Right-click on the display screen and select **Set All as Reference Boundary**.

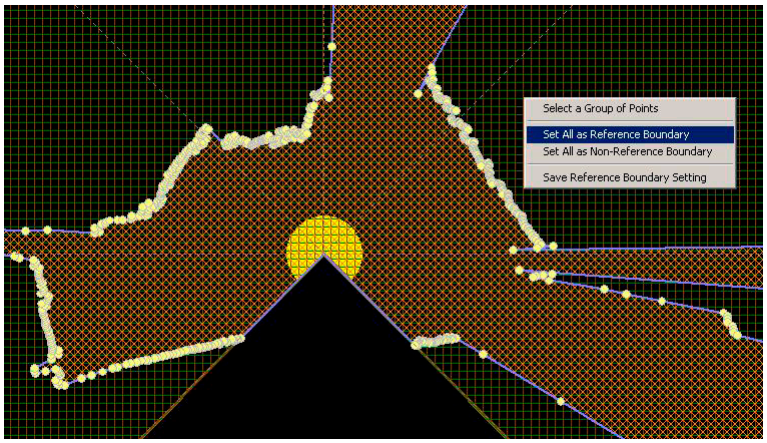

Select a Group of Points
Set All as Reference Boundary
Set All as Non-Reference Boundary
Save Reference Boundary Setting

Fig. 3-44 Set All as Reference Boundary

b. To select a group of points to be used for RBM:

•Right-click on the display screen and select **Select a Group of Points**.

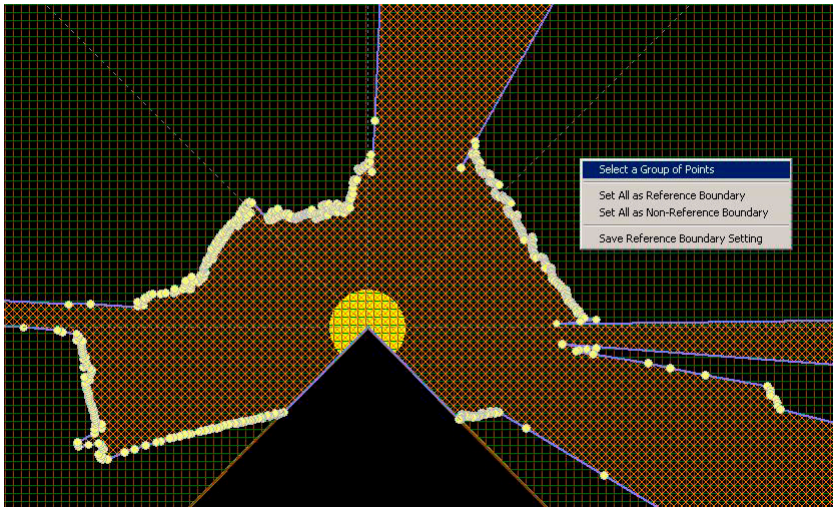

Select a Group of Points
Set All as Reference Boundary
Set All as Non-Reference Boundary
Save Reference Boundary Setting

Fig. 3-45 Select Group of Points

•Select a group of consecutive points so that the distance between the first point and the last point is at least 70mm (the OS32C's resolution). Use the coordinates in the status bar at the bottom of the screen to help determine the distance between points.

•Right-click on the display screen again and select **Set Point as Reference Boundary**.

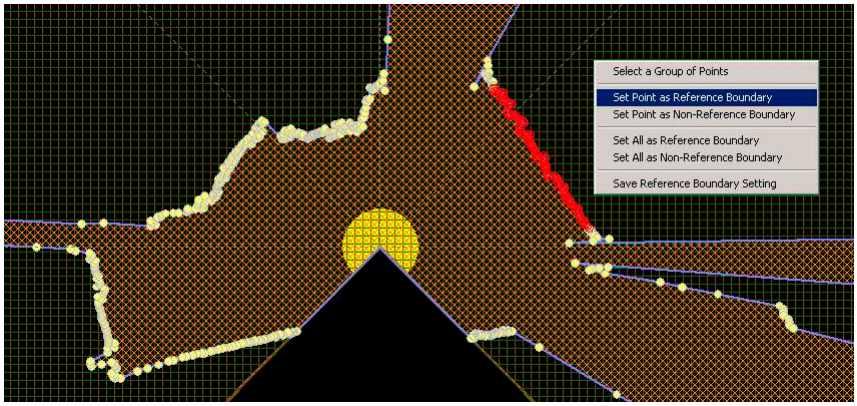

Select a Group of Points
Set Point as Reference Boundary
Set Point as Non-Reference Boundary
Set All as Reference Boundary
Set All as Non-Reference Boundary
Save Reference Boundary Setting

Fig. 3-46 Set Points as Reference Boundary Points

•Repeat as needed.

c. To cancel RBM for the zone,

•Right-click on the display screen and select **Set All as Non-Reference Boundary** and select **Save Reference Boundary Setting**.

Fig. 3-47 Cancel RBM Settings

8. When done selecting the points for RBM, right-click on the display screen and select **Save Reference Boundary Setting**.

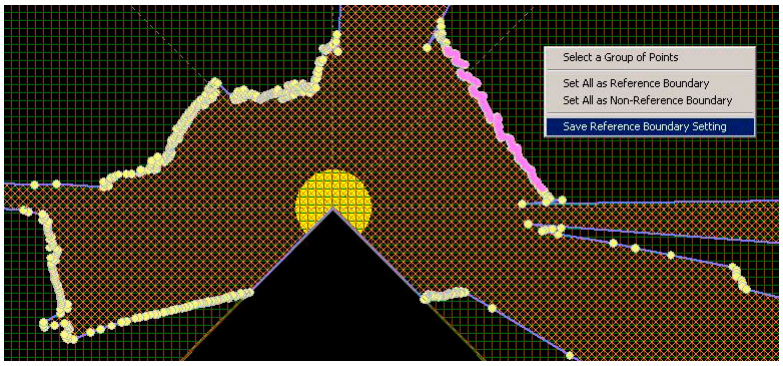

Select a Group of Points
Set All as Reference Boundary
Set All as Non-Reference Boundary
Save Reference Boundary Setting

Fig. 3-48 Save Reference Boundary Setting

9. Now that the Reference Boundary is set, click OK at the prompt shown below.

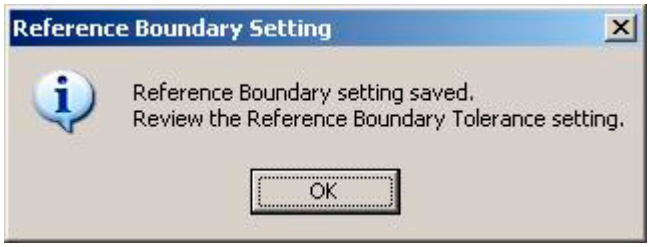


Fig. 3-49

10. Specify the allowed tolerance for RBM.

Fig. 3-50 RBM Tolerance

11. Send the created zone information to the OS32C for registration. From the **Configuration** menu, click **Send to Sensor/Enter CFG Mode**, **All Changes**. Configure by following the instructions displayed.

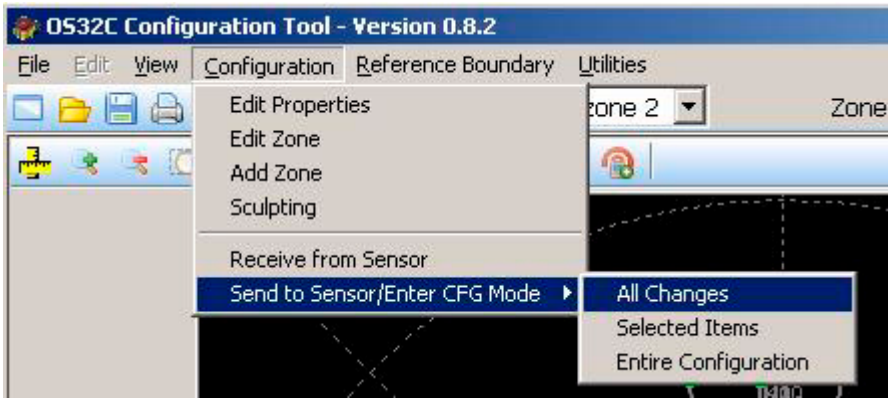


Fig. 3-51 Send to Sensor

12. Follow the prompt to reset the OS32C. Now configuration is complete.

CHECK!

- Safety and warning zones must be configured so that they maintain a distance of 100mm from the wall or fixtures.
- While executing the [Sculpting] command, a warning zone cannot be set with the range exceeding 10 meters. Use [Edit Zones] or [Convert Shape To] command to modify the shape of the warning zone.

Monitor Mode

The configuration software can display scanning zone information of the OS32C in real-time without stopping the machine. The monitor mode can be used by logging on to the OS32C with either operator access level or supervisory access level.
To start the monitor mode, select **System Monitoring** from the **Utilities** menu. To terminate, follow the same step and deselect **System Monitoring**.

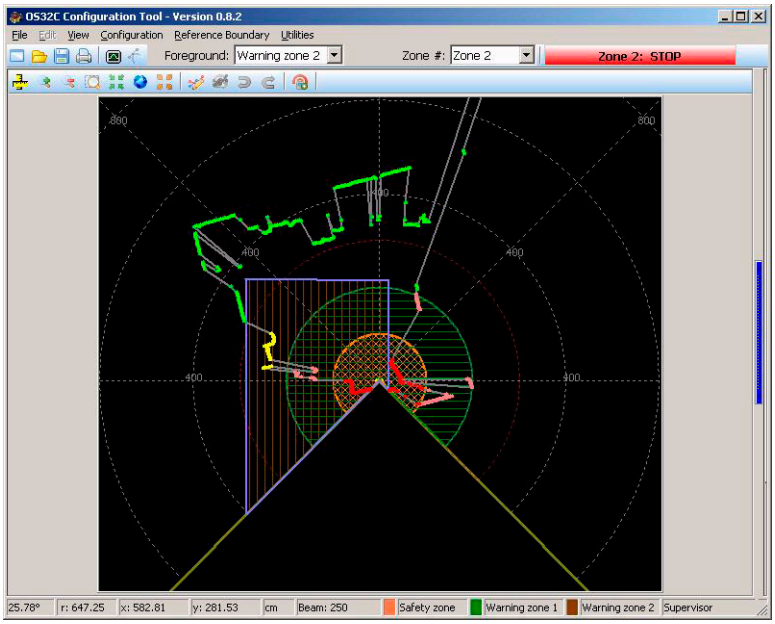


Fig. 3-52 System Monitoring

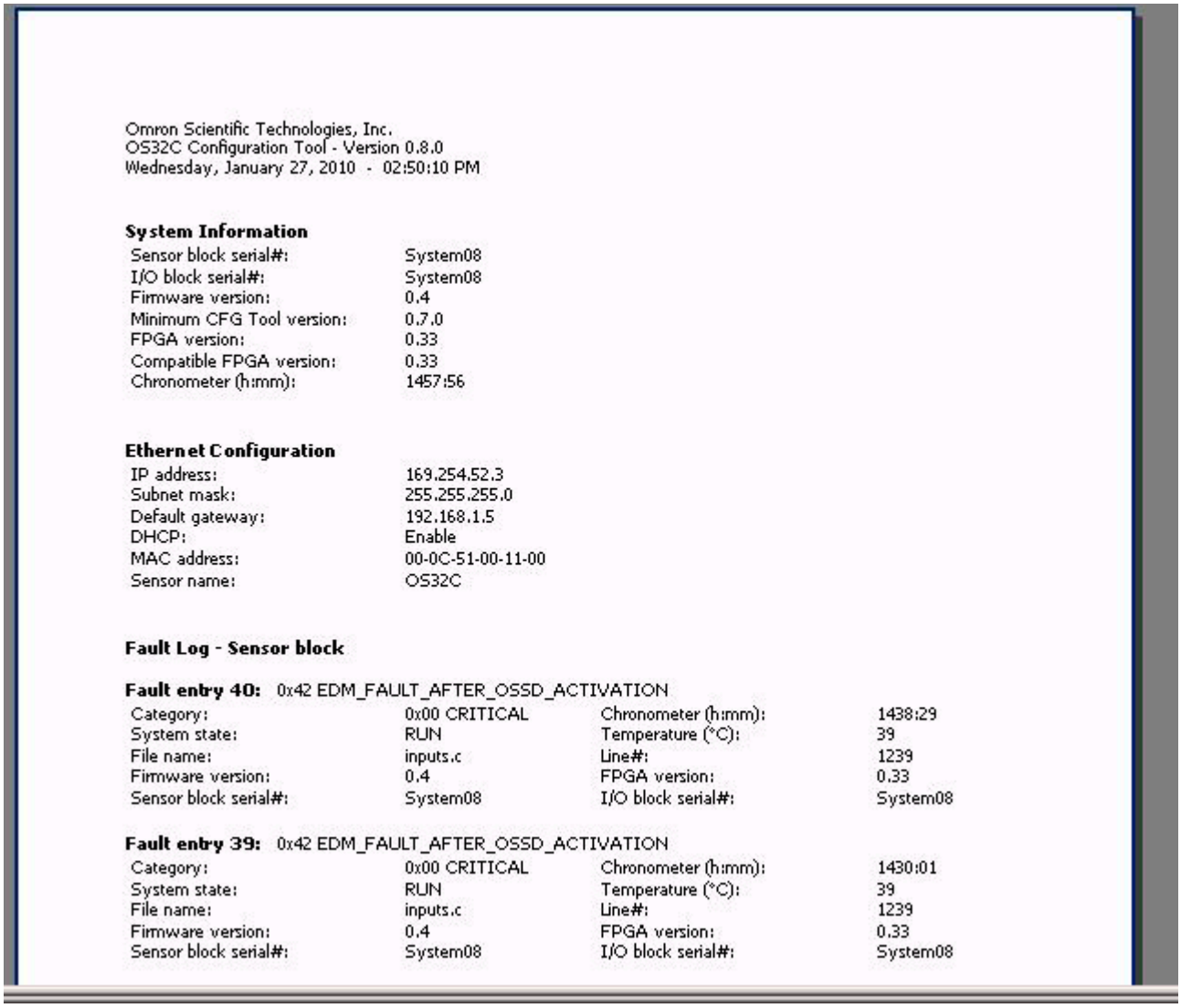
The outmost border indicates a scanning zone of the OS32C on the diagram above. A zone marked in pink indicates the intruded area in the warning zone 1, a zone marked in yellow indicates the intruded area in the warning zone 2, while a zone marked in red indicates the intruded area in the safety zone. The zone selected in **Foreground** is displayed as purple line. (In this example, **Zone 2** and **Warning zone 2** are selected)
Under the monitor mode, the OS32C state is displayed on the main tool bar.

Read Fault Log

There are separate fault logs for the sensor block and for the IO block. Each fault log contains the most recent 100 faults that have occurred. Fault entries are shown with the most recent faults first, so fault entry #1 is the oldest fault.

To retrieve a fault log:

1. From the **Utilities** menu, select **Read Fault Log**.
2. Select sensor block or IO Block.
3. Print or save the error log to a text file.



Omron Scientific Technologies, Inc.
OS32C Configuration Tool - Version 0.8.0
Wednesday, January 27, 2010 - 02:50:10 PM

System Information

Sensor block serial#:	System08
I/O block serial#:	System08
Firmware version:	0.4
Minimum CFG Tool version:	0.7.0
FPGA version:	0.33
Compatible FPGA version:	0.33
Chronometer (h:mm):	1457:56

Ethernet Configuration

IP address:	169.254.52.3
Subnet mask:	255.255.255.0
Default gateway:	192.168.1.5
DHCP:	Enable
MAC address:	00-0C-51-00-11-00
Sensor name:	OS32C

Fault Log - Sensor block

Fault entry 40: 0x42 EDM_FAULT_AFTER_OSSD_ACTIVATION

Category:	0x00 CRITICAL	Chronometer (h:mm):	1438:29
System state:	RUN	Temperature (°C):	39
File name:	inputs.c	Line#:	1239
Firmware version:	0.4	FPGA version:	0.33
Sensor block serial#:	System08	I/O block serial#:	System08

Fault entry 39: 0x42 EDM_FAULT_AFTER_OSSD_ACTIVATION

Category:	0x00 CRITICAL	Chronometer (h:mm):	1430:01
System state:	RUN	Temperature (°C):	39
File name:	inputs.c	Line#:	1239
Firmware version:	0.4	FPGA version:	0.33
Sensor block serial#:	System08	I/O block serial#:	System08

Fig. 3-53 Fault Log

Window Calibration

If the scan window of the OS32C is replaced, window calibration needs to be performed. Do not execute window calibration except when the scan window is replaced. The steps shown below describe this process. The window calibration procedure resets the threshold values of window transmittance, which is used for window contamination warning detection. To execute this procedure, the user must log on with the supervisory access level.

1. From **Utilities** menu, select **Window Calibration**.
2. A screen shown below is displayed. Click **Yes** to confirm.

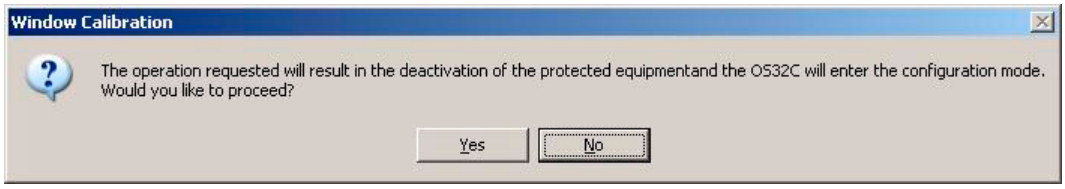

Window Calibration
The operation requested will result in the deactivation of the protected equipmentand the OS32C will enter the configuration mode.
Would you like to proceed?
Yes
No

Fig. 3-54 Window Calibration

3. When window calibration starts, the window shown below is displayed.

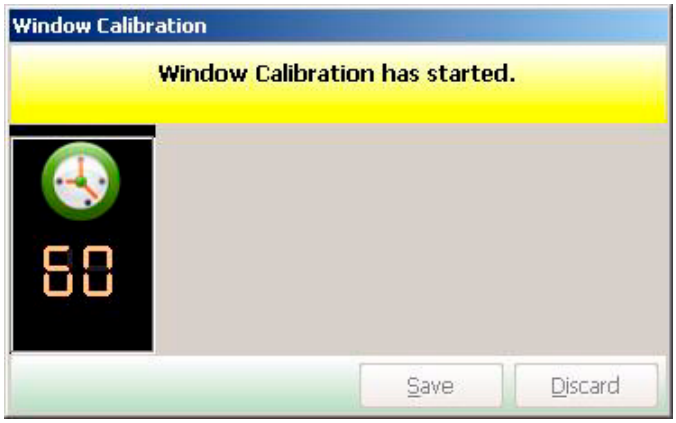


Fig. 3-55 Calibration Starts

4. When calibration is successfully completed, the window shown below is displayed. Click **Save** to confirm.

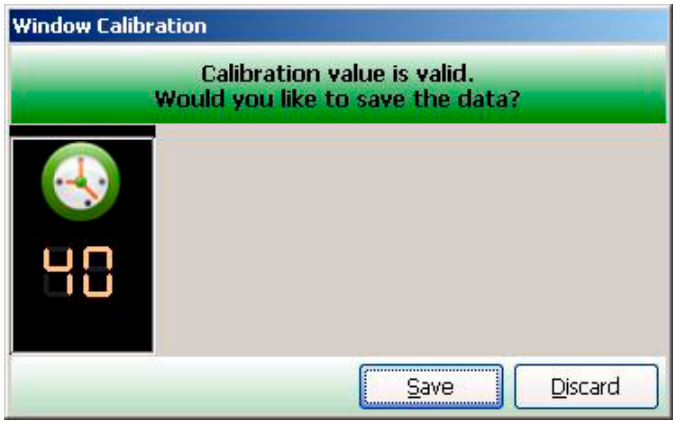


Fig. 3-56 Calibration Success

Confirm that the window calibration data has changed, and wait for the OS32C to reset. Calibration is complete.

The window shown below may be displayed even after replacing the scan window, due to dust or finger prints on the scan window or dust detection surface during replacement. Clean the inside and outside of the scan window and surface of the dust detection surface using a soft cloth.

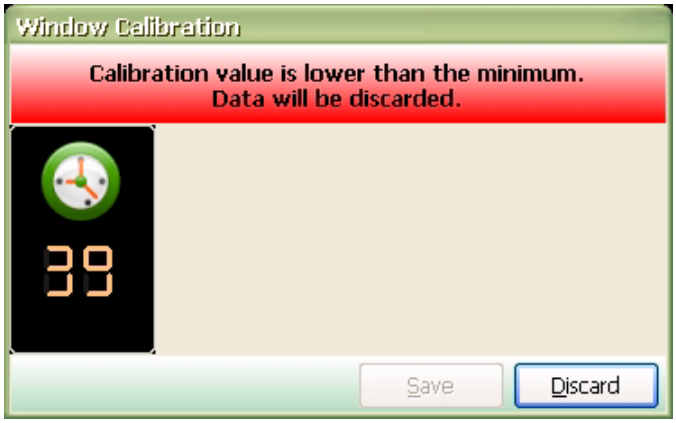


Fig. 3-57 Calibration Value too Low

Changing Options of Configuration Software

This section describes how to change options of the configuration software.

1. From **Utilities** menu, click **Options**.
2. The Options screen is displayed.

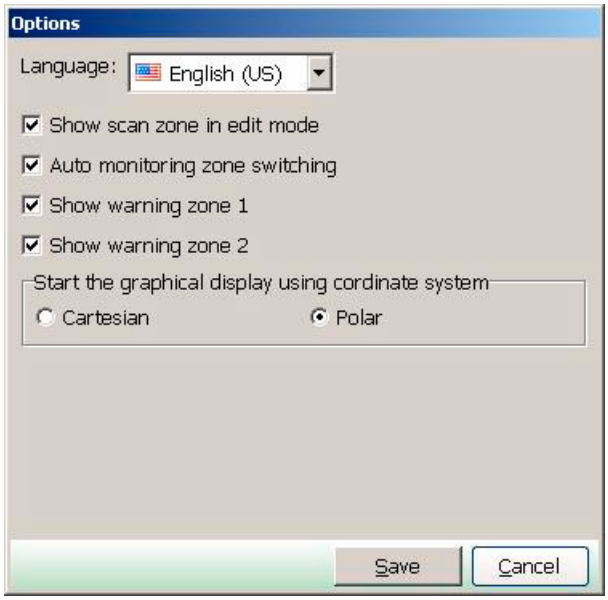


Fig. 3-58 Changing Configuration Software Options

3. Edit an item you want to change.
4. After configuration is finished, click **Apply**.
5. A screen shown below is displayed. Click **OK**.

Fig. 3-59 Apply Option Changes

Caution on Safety Zone Configuration

Due to the scanner's minimum object resolution criteria, it is possible to configure zones that are not considered valid. These zone configurations may contain a protrusion or intrusion that is narrower than 70mm in width within the field of view. This type of invalid zone configuration can only occur within a distance of 4 meters from the scanner.

Narrow protruding areas less than 70mm wide are NOT valid zone perimeters. A scanner configured with such a safety zone would see a presence within this area (if in monitor mode), but would not initiate a machine stop. The following pictures shows a possible zone configuration that contains a protrusion that is narrower then 70mm in width, since this protrusion is less than 70mm in width it will not detect a 70mm object. Refer to Fig. 3-60

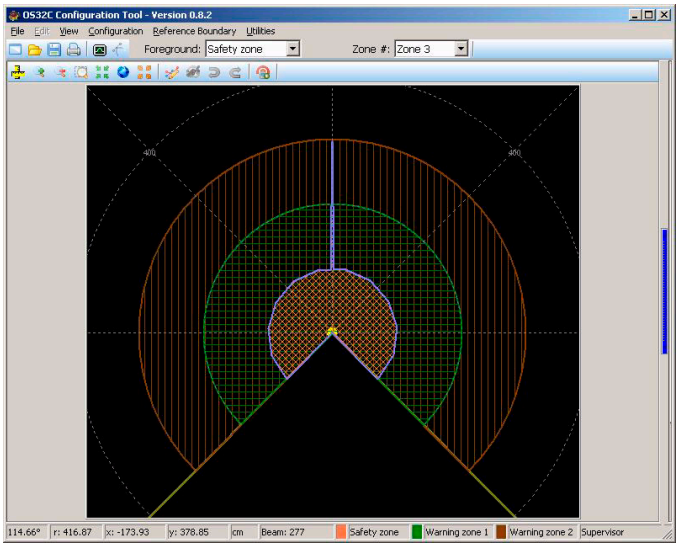

OS32C Configuration Tool - Version 0.8.2
File Edit View Configuration Reference Boundary Utilities
Foreground: Safety zone
Zone #: Zone 3
400
400
114.66° r: 416.87 x: -173.93 y: 378.85 cm Beam: 277 Safety zone Warning zone 1 Warning zone 2 Supervisor

Fig. 3-60 Detection Zone in Protruding Part

Narrow intruding areas less than 70mm wide are NOT valid zone perimeters. A scanner configured with such a safety zone would see a presence within this area (if in monitor mode), but would not initiate a machine stop. The following pictures shows a possible zone configuration that contains an intrusion that is narrower than 70mm in width, In this case the scanner has two fields of view and the object must be entirely in the left or right field of view to be detected, therefore this narrow intrusion of less than 70mm in width is not a valid zone. Refer to Fig. 3-61

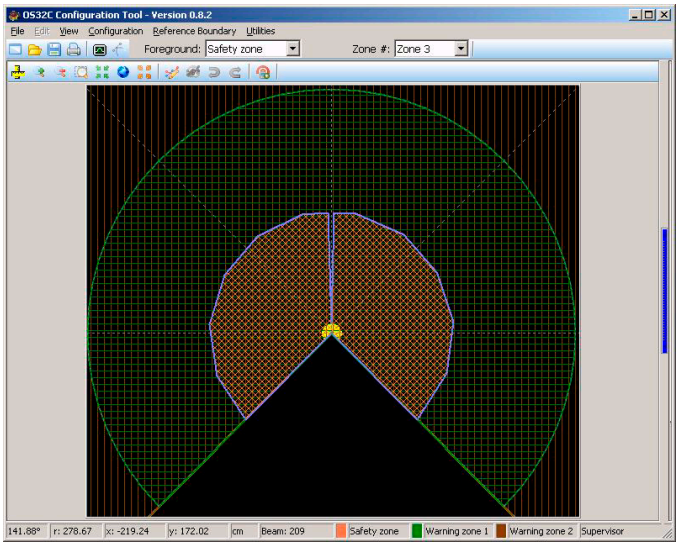

OS32C Configuration Tool - Version 0.8.2
File Edit View Configuration Reference Boundary Utilities
Foreground: Safety zone
Zone #: Zone 3
141.88° r: 278.67 x: -219.24 y: 172.02 cm Beam: 209 Safety zone Warning zone 1 Warning zone 2 Supervisor

Fig. 3-61 Detection Zone in Intruding Parts

Chapter4 Installation

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Mounting Considerations

⚠ CAUTION

Operation of the OS32C may be affected by light in the environment, such as incandescent light, strobe light and light from a photosensor using infrared light.

Operation of the OS32C may be affected by substances in the environment, such as fog, smoke, steam and other small particles.

The following considerations should be taken into account when determining the mounting location for the OS32C. It is possible for ambient light to interfere with normal operation of the OS32C. Ambient light interference DOES NOT lead to a loss of safety, it may, however, cause false nuisance stops of the guarded equipment.

Some installations may require that the OS32C be mounted in direct exposure to ambient light. In these situations you must assure that the separation between the scan plane of the OS32C and the light source be greater than +/-5°.

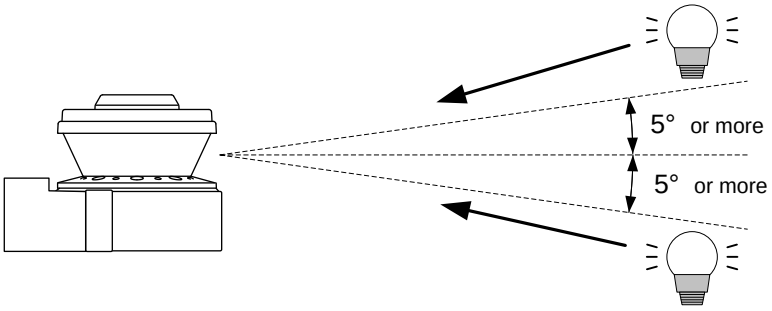


Fig. 4-1 Angle between scan plane and light source

Configuring Multiple OS32C Scanners

The possibility exists that two OS32C may interfere with each other. To avoid this when using multiple OS32C in the same location, please review the following mounting recommendations.

- •Adjust the scanners to offset the scanning plane by tilting the OS32Cs.
- •Adjust the scanners to offset the scanning plane by mounting the OS32Cs at different heights.
- •Adjust the scanners to different scanning planes and additional sampling scans (response time) on the OS32Cs.
- •Install a barrier to block the direct path of possible signal crossing.

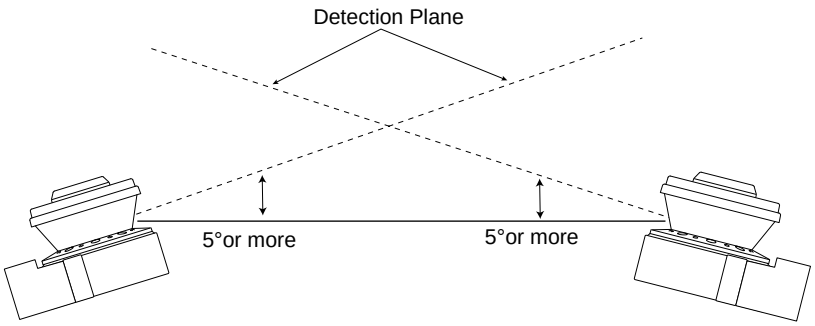


Fig. 4-2 Offset Scanning Level by Tilting

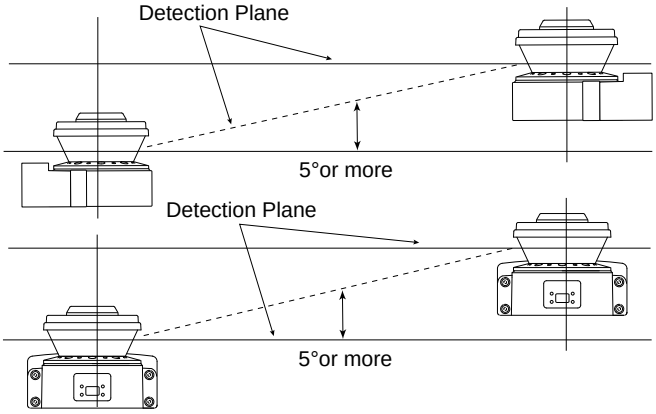


Fig. 4-3 Offset Parallel Scanning Levels by Different Installation Height

CHECK!

When installing the OS32Cs side by side, it is more effective to set their mounting heights differently. When adjusting the OS32C tilted, it may be more effective to adjust the OS32C downward depending on the condition of the outside light source (natural light or halogen light).

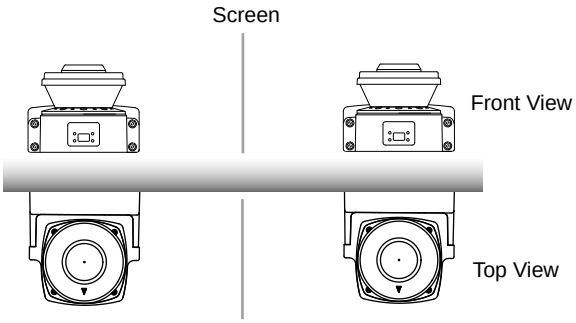


Fig. 4-4 Separation using a screen

CHECK!

Use of a screen may increase the effect of reflection depending on its material. Select one with matte black finish that is resistant to reflection.

Distance from Wall

The safety or warning zones must be configured so that they maintain a distance of 100mm from the wall or tooling fixture.
If sculpting is performed, the distance is automatically configured with a stand-off distance of 100mm from walls.

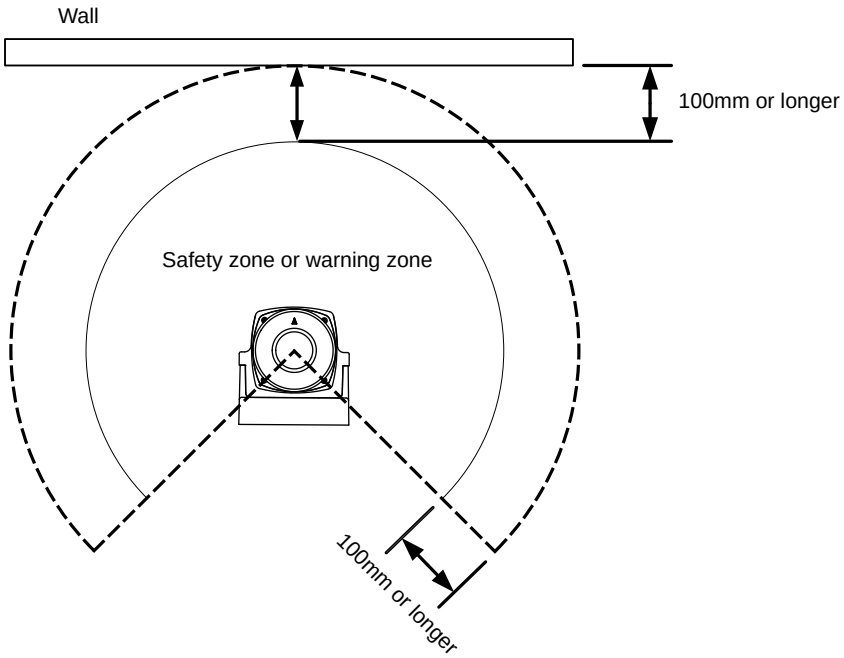


Fig. 4-5 Distance from Wall

Stationary Installation and Configuration

Installation for Stationary Area Scanning

■ Position

The OS32C must always be installed in a position that the safety zone can cover the danger area being scanned.
Area which cannot be scanned (e.g. behind obstacles) must be secured by taking appropriate additional measures (e.g. barriers).

The reset switch for clearing interlock must be positioned in such a way that the entire monitoring zone is in view and the operating element cannot be reached from inside the monitored zone.

■ Installation Height (Detection Level)

The installation mounting height of the OS32C is very important, and the following considerations should be taken into account to determine the mounting height.

The OS32C must be mounted in such a way to prevent access to the hazardous area, personnel should not be able to crawl under, stand behind or climb over the protective field. According to EN999, for an installation height exceeding 300mm, the possibility of creeping under the protective field must be taken into account.

Always mount the OS32C so that it is protected from moisture and dirt. Mount the scanner so that the indicators are visible. Avoid locations where the OS32C is exposed to excessive shock and vibration.

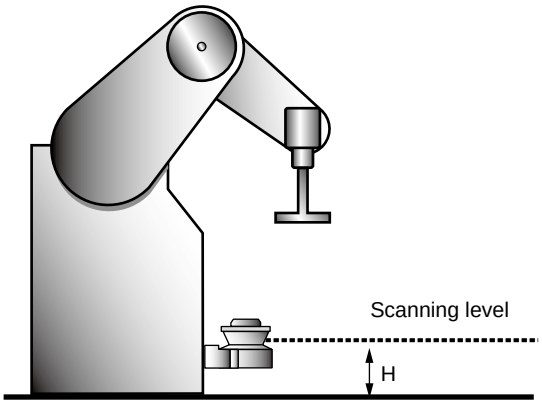


Fig. 4-6 Installation Height

Configuration

When using the OS32C to detect the hazardous area, the Start/Restart Interlock mode should be selected; the regulations applying to the machine must also be complied with.

■ Safety Distance (Required Depth of Safety Zone)

Always configure the safety zone in such a way that the machine comes to a standstill in a time less than that taken to reach the danger point of the machine after infringing (interrupting) the safety zone. The standard ISO 13855-2005 (EN 999-1998) must be used to calculate the minimum safety distance; according to ISO 13855-2005 (EN 999-1998), the minimum safety distance, S, from the danger zone area to the outer edge of the safety zone is calculated as follows:

$S = (K \times T) + C + Z$

where:

S = Minimum safety distance in mm measured from the danger area to the outer contour of the safety zone.

K = Movement or approach speed in mm/s (constant K = 1600 mm/s)

T = Delay between interruption of the safety zone and standstill of the machine in seconds consisting of the sum of t_1, t_2 and t_3:

t_1 = Response time of the OS32C

t_2 = Rundown time of the machine (mechanical rundown, reaction time of control system)

t_3 = additional time delay for use when multiple zones are used (t3 = 10 ms.)

C = Safety constant with C = 1200 mm - 0.4 x H ($C \geq 850$); where

H = Distance of detection level from reference level in mm

Z = Additional safety factors (maximum measurement error) ($Z = Z_1 + Z_2$),

Z_1 = The OS32C's maximum measurement error (100mm)

Z_2 = Additional error by reflective background (Additional Error due to Reflective Background p.114)

■ Documentation of Configuration Parameters

The person responsible for the set-up must record the configuration parameters, print out and sign the report.

•Connect the printer to the PC.

•Select the menu "File/Print Configuration" in the configuration software.

•The report is printed out.

•Sign and date the report and file it in a known location which is always accessible.

Configuration Example: Installation on a Machine (1)

An example of the installation of OS32C without undercut on the machine is shown below.

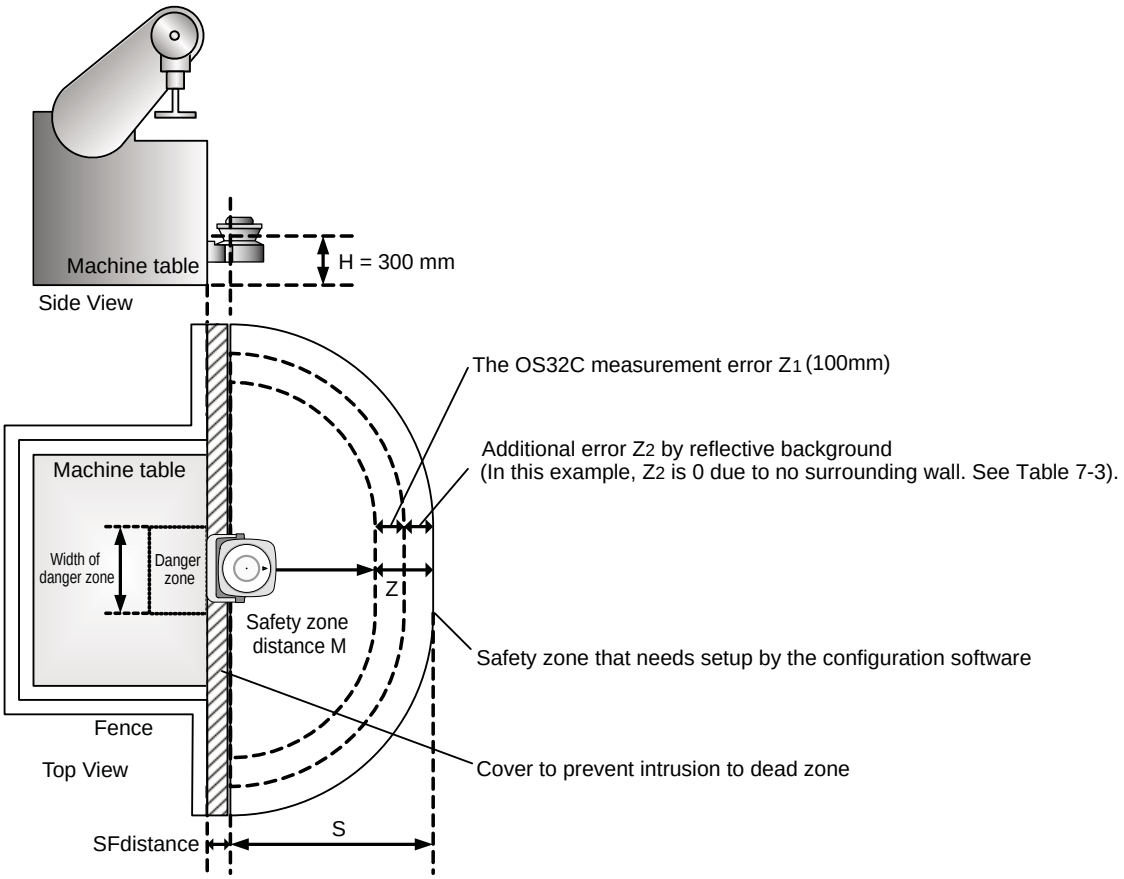

Machine table
H = 300 mm
Side View
The OS32C measurement error Z1 (100mm)
Additional error Z2 by reflective background
(In this example, Z2 is 0 due to no surrounding wall. See Table 7-3).
Machine table
Width of danger zone
Danger zone
Z
Safety zone distance M
Safety zone that needs setup by the configuration software
Fence
Top View
Cover to prevent intrusion to dead zone
S
SFdistance

Fig. 4-7 Installation on a Machine

■ Specifications

K = 1600mm/s: Movement or approach speed (mm/s)

$T = t_1 + t_2$

t_1 = 0.08s: Response time of OS32C (s)

t_2 = 0.2s: Stop time including response time of machine (s)

C = 1200mm - 0.4xH ($C \geq 850$mm): safety factor (mm)

H = 300mm: Distance of detected level from reference level (mm)

$Z = Z_1 + Z_2$

Z_1 = 100mm: OS32C's measurement error (mm)

Z_2 = 0mm: Additional error by reflective background (mm)

■ Calculation Example of Safety Distance S

S = (K x T) + C + Z

= 1600 mm/s x (0.08 s+0.2 s) + (1200 mm - (0.4 x 300 mm)) + 100 mm

= 448 mm + 1080 mm +100 mm

= 1628 mm

There are several different ways to install the OS32C as shown in Fig. 4-8. Each length of SFdistance (the potential dead space indicated in Fig. 4-7 between the OS32C and the danger zone) is different.

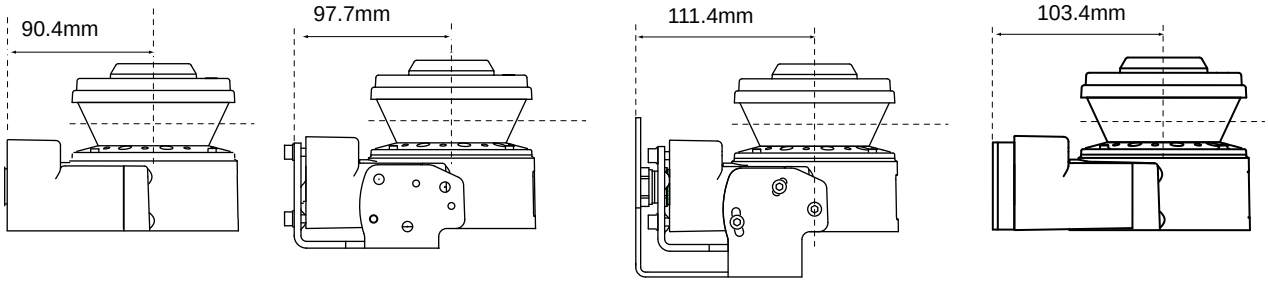


Fig. 4-8 Dimensions of SFdistance

Take additional precautions to prevent intrusion to the dead zone after determining how to mount the OS32C.

■ Additional Error Z_2 due to Reflective Background

(1) High-reflective background material or object is present in the scanning plane and within 1.2m beyond the safety zone.
(e.g. acrylic panel, stainless steel, reflective tape, mirror)
(2) Low-reflective background material or object is present in the scanning plane and within 1.2m beyond the safety zone.
(e.g. paint-finished equipment)

If any of the conditions listed above apply to your application, an additional error factor Z_2 should be added to the safety zone.

Additional Error due to Reflective Background p.114

Configuration Example: Installation on a Machine (2)

An example of installing a cover on the machine with undercut to mount the OS32C is shown below.
The OS32C needs to be installed so that the operator cannot stand between the safety zone and danger zone.
Set a cover or undercut on the machine as shown in Fig. 4-9 so that the operator cannot stand on the dead zone.

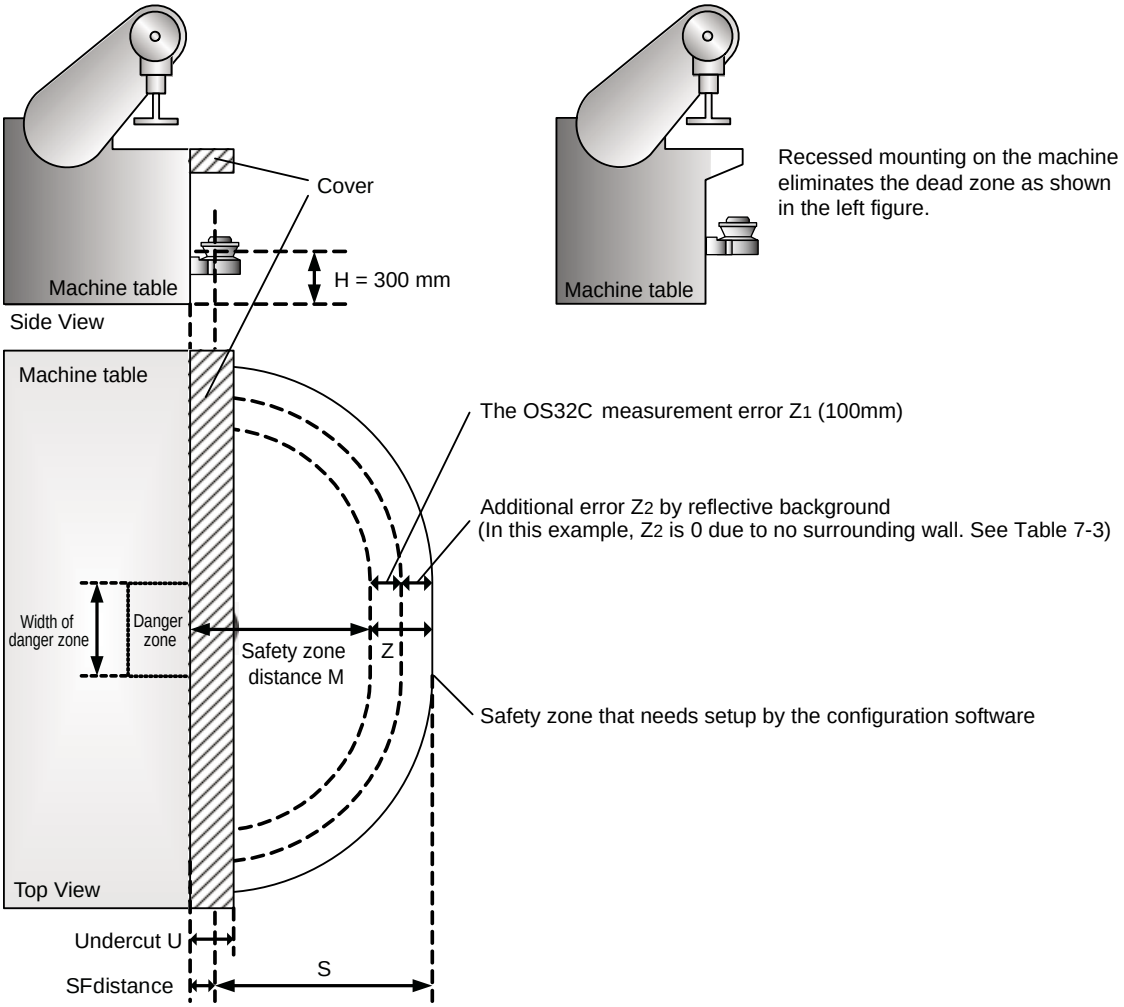

Cover
Machine table
H = 300 mm
Side View
Machine table
Recessed mounting on the machine eliminates the dead zone as shown in the left figure.
Machine table
Machine table
The OS32C measurement error Z1 (100mm)
Additional error Z2 by reflective background
(In this example, Z2 is 0 due to no surrounding wall. See Table 7-3)
Width of danger zone
Danger zone
Safety zone distance M
Z
Safety zone that needs setup by the configuration software
Top View
Undercut U
SFdistance
S

Fig. 4-9 Installation on a machine with cover

Put a cover on the OS32C as shown in Fig. 4-9 to cover the dead zone and prevent entry to the "Undercut U and SFdistance"

The calculation example of safety distance S and SFdistance are the same as Configuration Example: Installation on a Machine (1).

Configuration Example: Entry Access Protection

An application example for perpendicular approach to the scanning plane is shown below (entry access protection for a vertical plane protection zone)
•Intrusion body detection protection

•Reference Boundary Monitoring (RBM) must be applied when the OS32C is used for Entry Access Protection guarding as specified in IEC61496-3:2008. Refer to page 19 for more information on RBM.

•To ensure adequate detection a response time of 80 mS is required. If the response time exceeds 80mS, a 70 mm object with a speed of 1.6 m/s may not be detected under certain circumstances.

•Additional counter measures for protection must be provided if there is a space between the protection zone and the machine hazard point.

•The OS32C can not be used in applications for hand and arm detection.

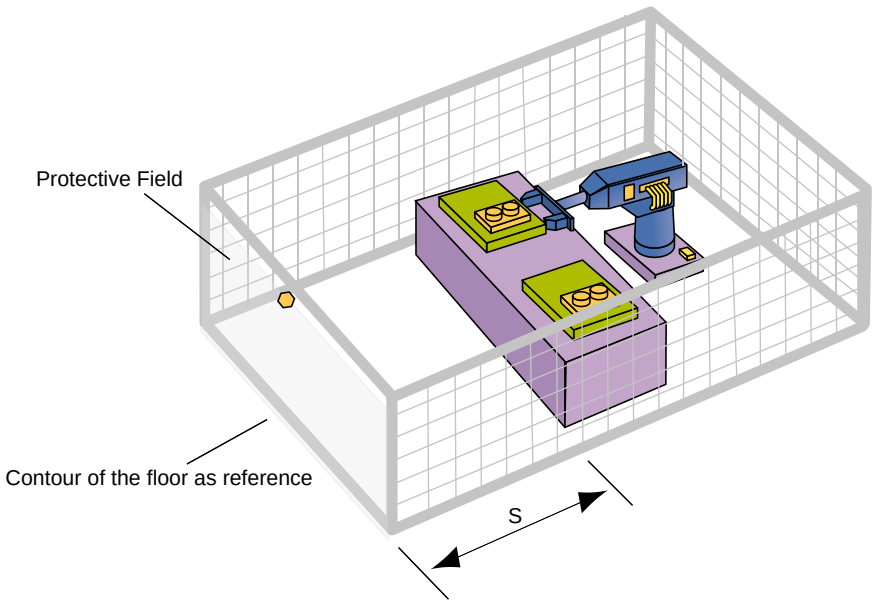


Fig. 4-10 Perpendicular Approach Installation

S = (K x T) + C

S = Minimum safety distance in mm measured from the danger area to the outer contour of the safety zone.

K = Movement or approach speed in mm/s (constant K = 1600 mm/s)

T = Delay between interruption of the safety zone and standstill of the machine in seconds consisting of the sum of t_1 and t_2.

t1 = Response time of the OS32C

t2 = Rundown time of the machine (mechanical rundown, reaction time of control system).

C = Additional supplemental distance in millimeters

■ Example of safety distance calculation

K = 1600 mm/s approach speed constant

T = t1+t2 = 0.58s Overall response time

t1 = 0.08 seconds OS32C response time (adjustable)

t2 = 0.5 seconds Max. time required to full stop of the machine

C = 850mm

S = K x T + C = 1600 x 0.58 + 850 = 1778 mm

Mobile Installation and Configuration

Applying OS32C on Automated Guided Vehicles (AGV)

AGVs equipped with an OS32C should only be used on private or company property and not allowed to operate on public streets. The OS32C must only be used in AGV applications where the vehicle is equipped with an electric motor. In addition to the following guidelines, it is important that you follow the AGV manufacturer's recommendations.

■ Positioning Height

The OS32C must be mounted so that it provides a horizontal safety scan plane in the path of the AGV.

The height of the scan plane must not exceed 200mm. It is recommended that the installation height of the scan plane be 150mm so that objects with a height of 150mm can be detected. After installation, the entire hazardous area must be tested to verify detection of the 150mm object.

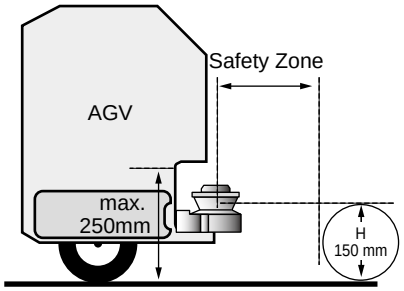


Fig. 4-11 Installation on Automated Guided Vehicle

■ Protruding Front End Mounting

When the application requires installation on the vehicle's front end, it is necessary to eliminate dead zones. These inactive zones can be minimized by recessed installation of the OS32C. On vehicles capable of speeds greater than 0.3m/sec within 3 seconds, the dead zone must be minimized to prevent the operator from standing in the non-detection zone. Additional guarding safety measures must be taken, i.e. hard guarding or pressure sensitive bumper.

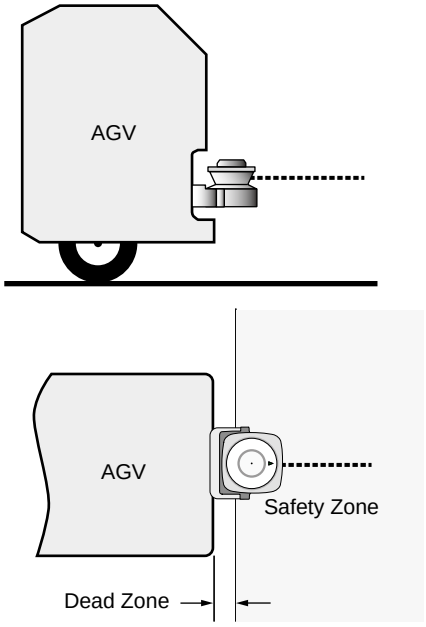


Fig. 4-12 Projecting Installation at Front of Vehicle

■ Recessed Front End Mounting

Although a recessed installation reduces the size of the dead zone, in some cases this technique creates dead angles. If the OS32C is mounted too deep within the vehicle, the OS32C will not be able to properly scan the hazardous area. These areas are referred to as Dead Angles, as shown in Fig. 4-13. On vehicles capable of speeds greater than 0.3m/sec within 3 seconds, additional safety measures must be taken.

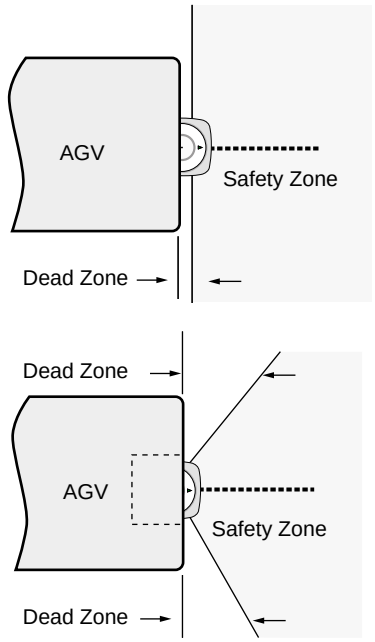


Fig. 4-13 Installation with Bodywork of AGV

■ Installation of OS32C

There are several different ways to mount the OS32C as shown in Fig. 4-14. The DFdistance (the minimum required clearance when installing the OS32C in a recessed location) needs to be considered depending on the mounting method.

Also, take additional precautions to prevent intrusion into the dead zone.

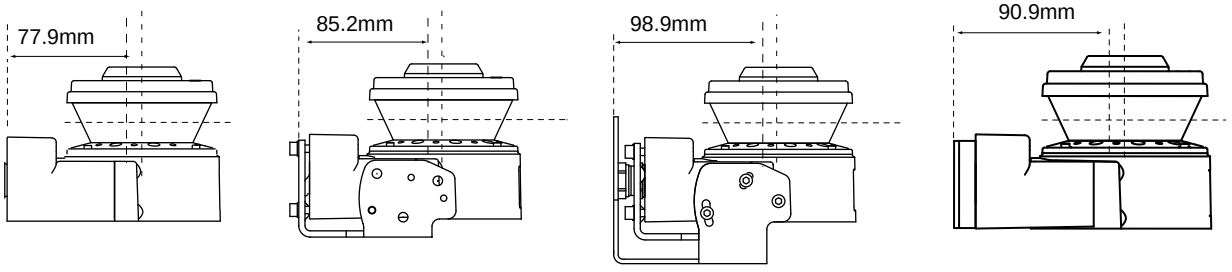


Fig. 4-14 Dimensions of DFdistance

Configuration for Automated Guided Vehicles (AGV)

■ Safety Distance (Safety zone depth required for safety zone)

For calculating the minimum safety distance for AGV, the standard IEC 61496-3 can be used. The safety distance, S, for use with an AGV should be calculated using the following formula:

S = Minimum safety distance in mm measured from the danger area to the outer contour of the safety zone.

S_p = Maximum stopping distance for AGV (mm)

Z = Additional safety factors (maximum measurement error)

With the conditions above, the minimum safety distance S is calculated as follows:

$S = S_p + Z$

$S_P = (V_{max.} \times T) + S_{brake}$

$Z = Z_1 + Z_2 + Z_{gc} + Z_{bf}$

V_{max} = Maximum speed of AGV in mm/s

T = Response time consisting of sum of t_1, t_2 and t_3:

t_1 = Response time of OS32C

t_2 = Response time of AGV

t_3 = additional time delay for use when multiple zones are used (t_3 = 10 ms.)

S_{brake} = Braking distance of AGV in mm based on manufacturer's document

Z_1 = OS32C's measurement error (100mm)

Z_2 = Additional error by reflective background (Additional Error due to Reflective Background p.114)

Z_{gc} = Safety factor for lack of clearance between under surface of AGV and ground (Fig. 4-15).

Z_{bf} = Safe factor for reduction of brake force of the AGV through wear and usage.

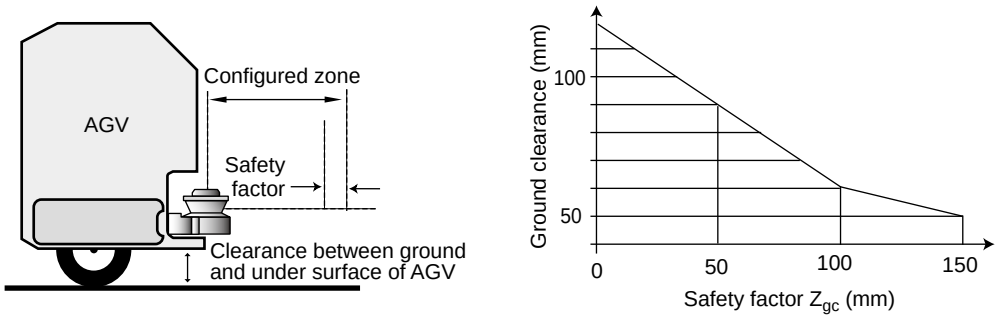


Fig. 4-15 Safety Factor for Low Ground Clearance

■ Safety Distance (Width Required for Safety Zone)

S_w = Minimum safety distance of safety zone width (mm)

V_w = Width of AGV (mm)

Z = Additional safety factors (maximum measurement error)

With the conditions above, the minimum safety distance S_w of safety zone width is calculated as follows:

$S_W = V_W + 2 \times Z$

$Z = Z_1 + Z_2 + Z_{gc} + Z_{bf}$

Z_1 = OS32C's measurement error (100mm)

Z_2 = Additional error by reflective background (Additional Error due to Reflective Background p.114)

Z_{gc} = Safety factor for lack of clearance between under surface of AGV and ground (Fig. 4-15).

Z_{bf} = Safe factor for reduction of brake force of the AGV through wear and usage.

Configuration Example: Use of an AGV

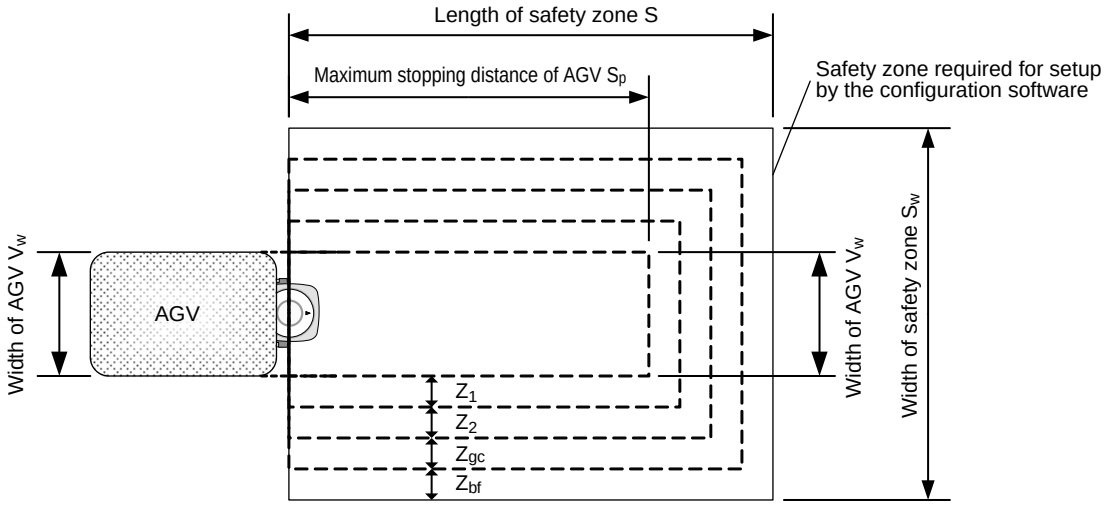


Fig. 4-16 Installation on AGV

■ Specifications

S_P = 1600 mm: Maximum stopping distance of AGV

V_W = 1100 mm: Width of AGV

Z_1 = 100 mm: OS32C's measurement error

Z_2 = 0 mm: Additional error by reflective background (no reflective background)

Z_{gc} = 50 mm: Safety factor for lack of clearance between under surface of AGV and ground

Z_{bf} = 100 mm: Safe factor for reduction of brake force of the AGV through wear and usage

Installation position = Centered

■ Calculation Example of Safety Distance (Safety Zone Depth)

$S = S_P + Z$

$= S_P + Z_1 + Z_2 + Z_{gc} + Z_{bf}$

= 1600 mm + 100 mm + 0 mm + 50 mm + 100 mm

= 1850 mm

■ Calculation Example of Safety Distance (Safety Zone Width)

$S_W = V_W + 2 \times Z$

$= VW + 2 \times (Z_1 + Z_2 + Z_{gc} + Z_{bf})$

= 1100 mm + 2 x (100 mm + 0 mm + 50 mm + 100 mm)

= 1600 mm

■ Additional Error Z_2 due to Reflective Backgrounds

If one of the conditions listed below applies to your application, an additional error factor Z_2 should be added to the safety zone.

(1) High-reflective background material or object is present in the scanning plane and within 1.2m beyond the safety zone.
(e.g. acrylic panel, stainless steel, reflective tape, mirror)

(2) Low-reflective background material or object is present in the scanning plane and within 1.2m beyond the safety zone.
(e.g. paint-finished equipment)

Additional Error due to Reflective Background p.114

AGV Standards

Safety and Machine standards vary from country to country and machine to machine.
The following related standards may be referenced:

•ASME/ANSI B56.5-1993
•EN 1493
•EN 1525
•IEC/EN 61496-3

External Dimensional Drawings

■ OS32C with Back Location Cable Entry (OS32C-BP)

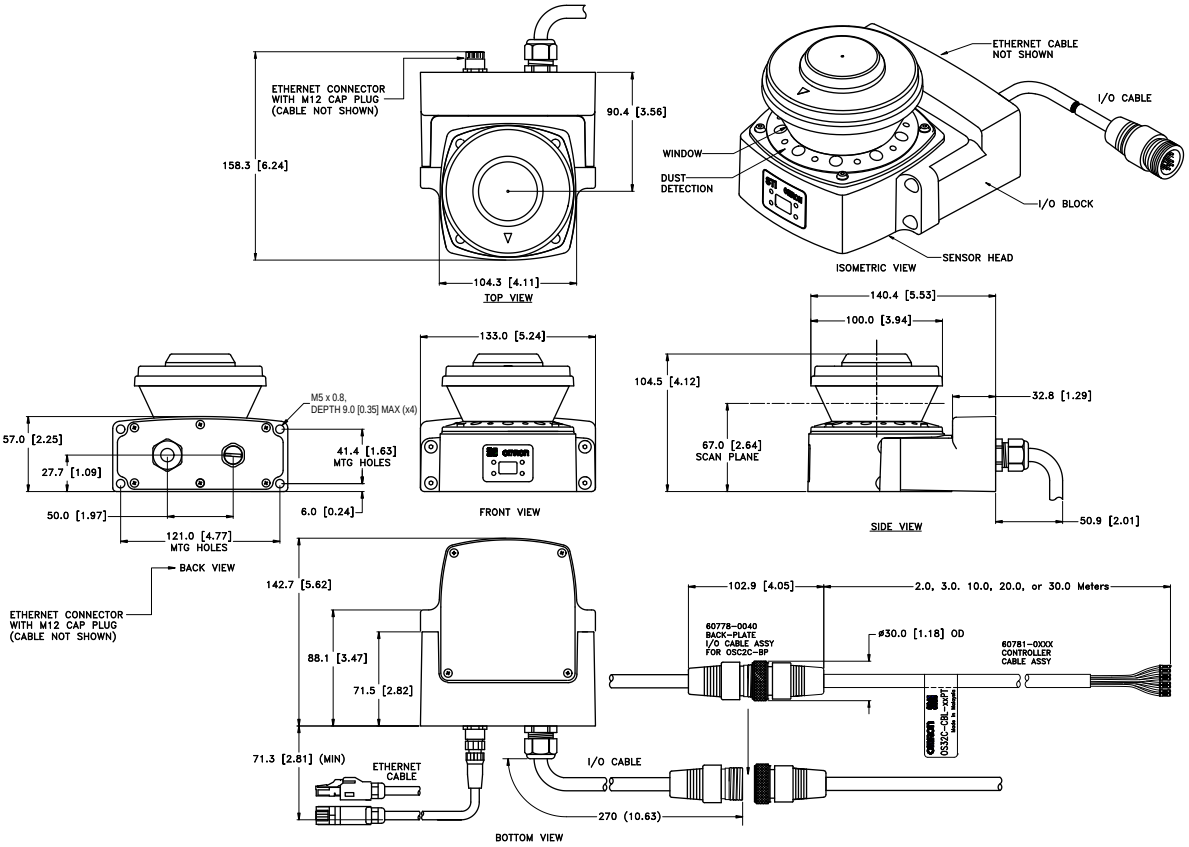


Fig. 4-17 OS32C with Back Cable Entry Dimensional Drawing

■ OS32C with Side Location Cable Entry (OS32C-SP1)

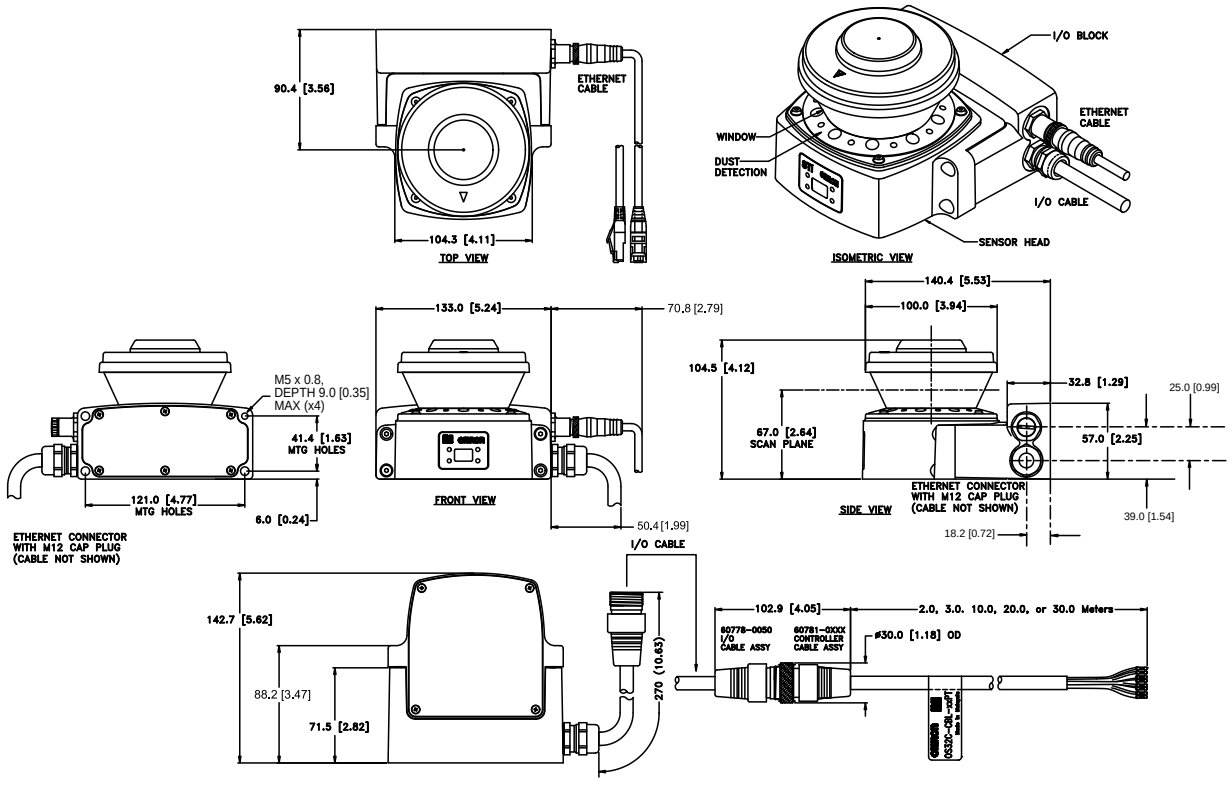


Fig. 4-18 OS32C with Side Cable Entry Dimensional Drawing

■ OS32C with Top Guard Kit Dimensional Drawing

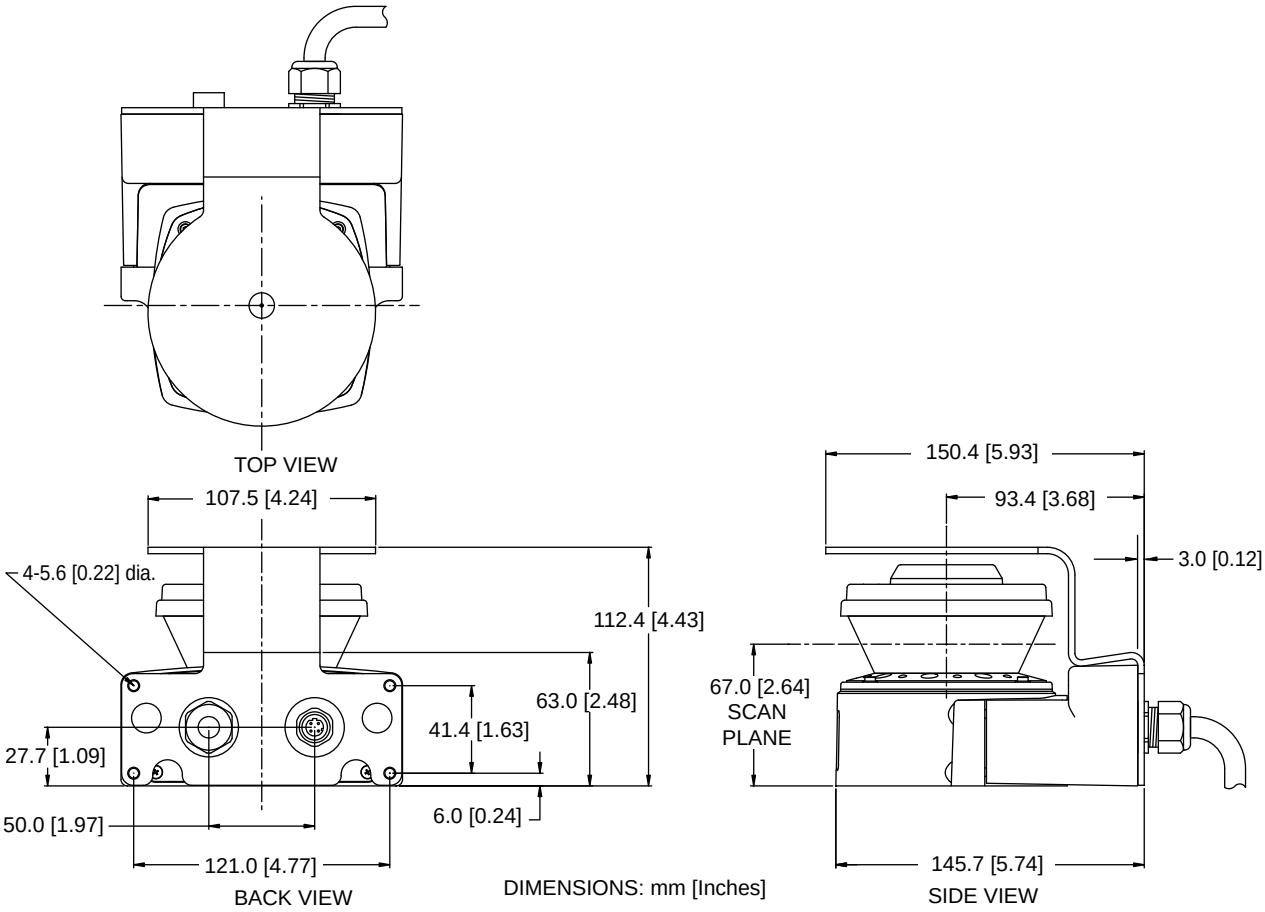


Fig. 4-19 Dimensional drawing of OS32C with Top Guard Kit OS32C-BKT4

■ OS32C with Top Guard Kit Assembly Drawing

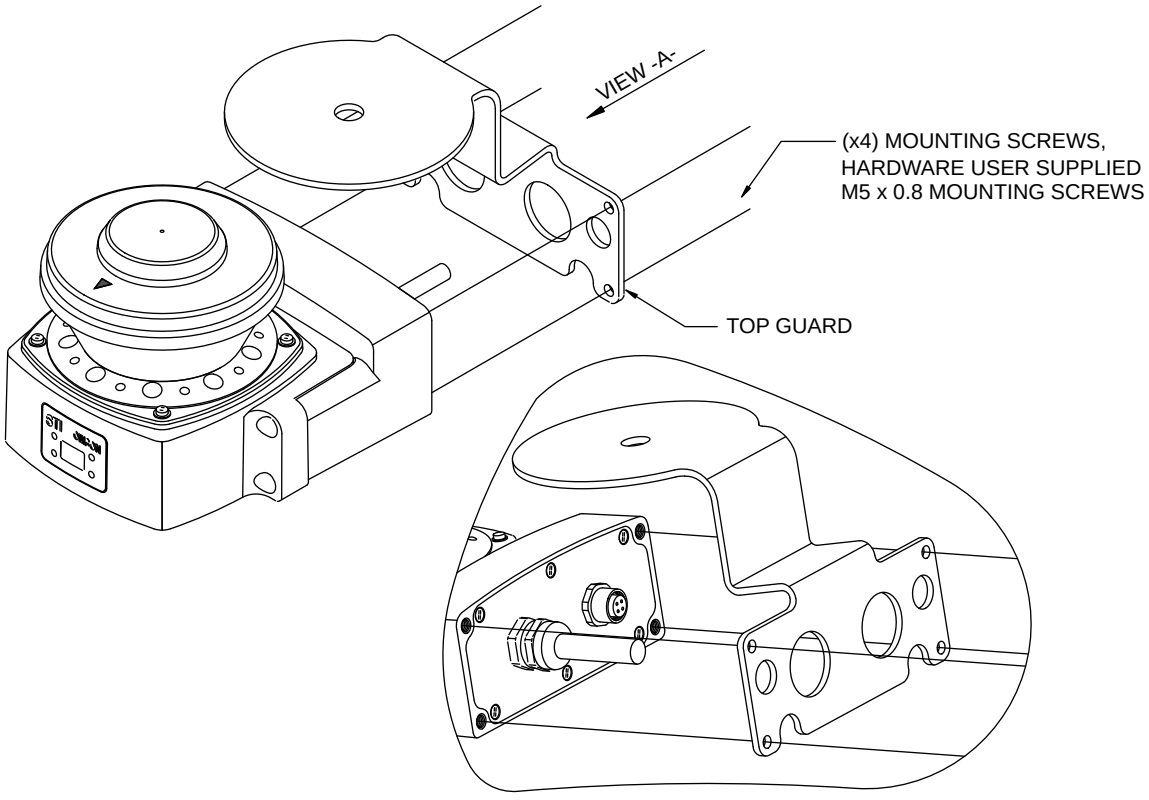


Fig. 4-20 Assembly drawing of OS32C with Top Guard Kit OS32C-BKT4

■ OS32C with Simple Mounting Bracket Assembly Drawing

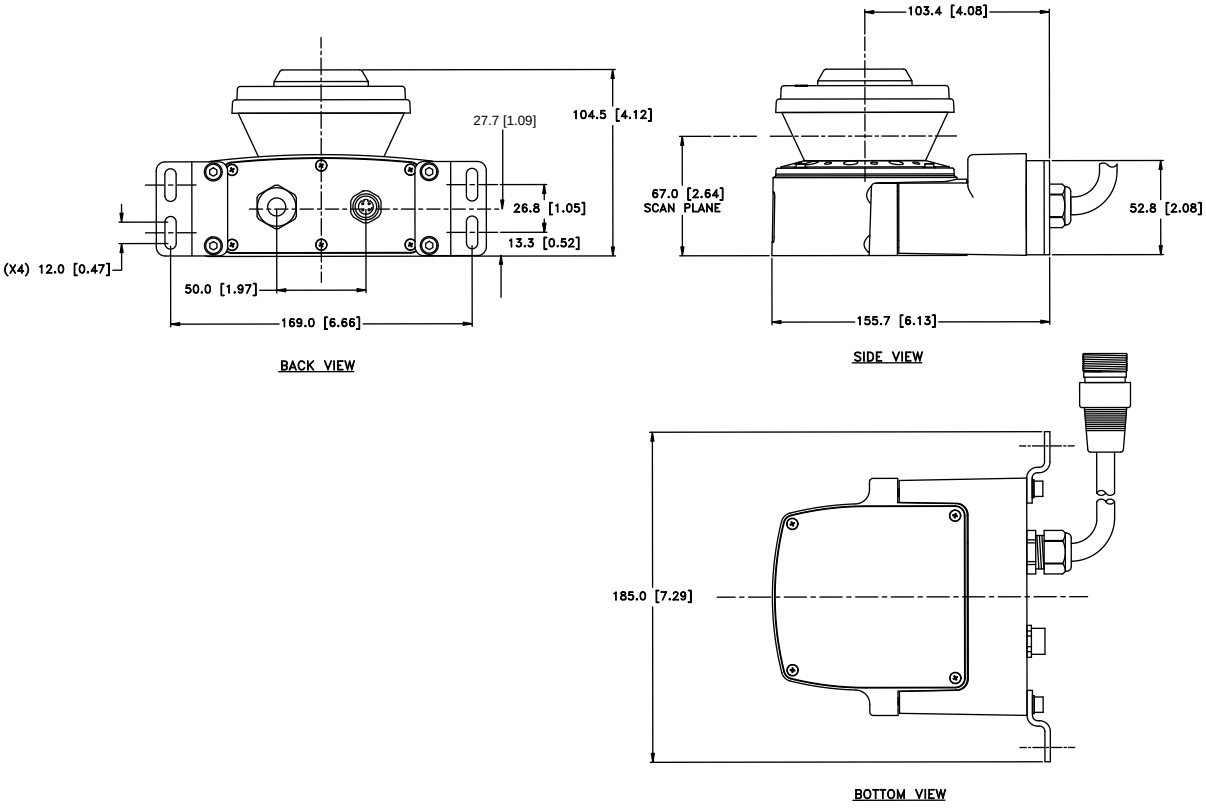
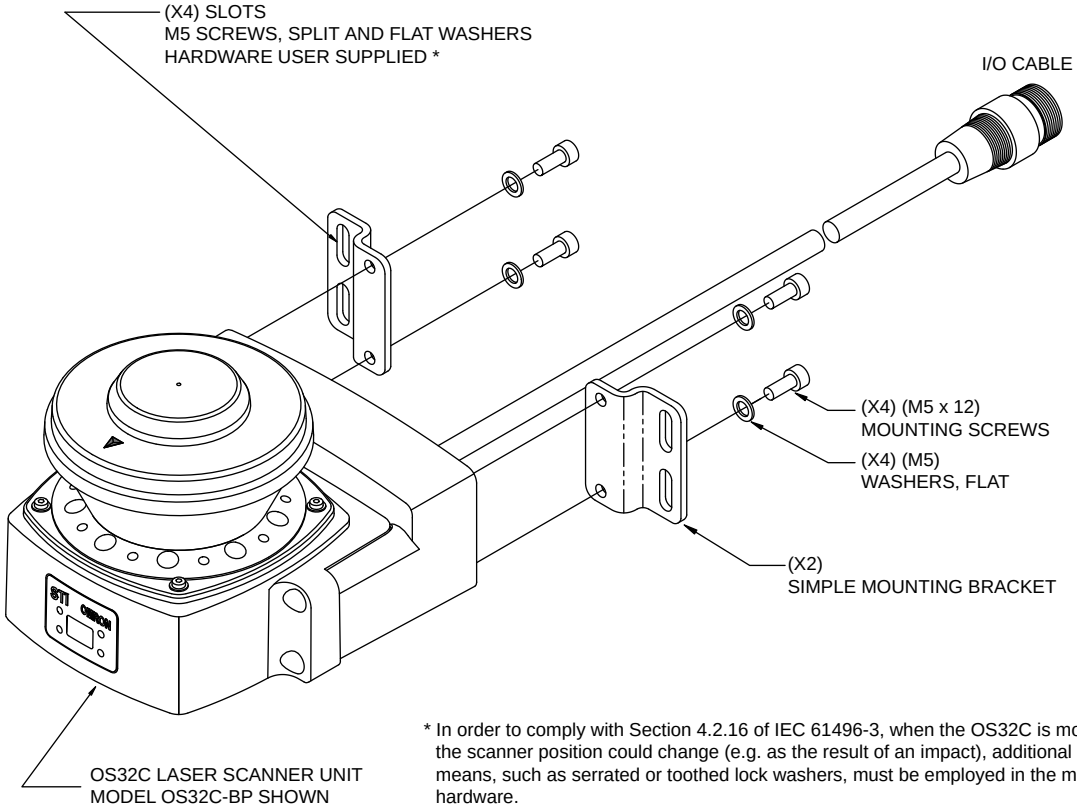


Fig. 4-21 Assembly drawing of OS32C with simple mounting bracket OS32C-BKT3

■ OS32C with Simple Mounting Bracket Dimensional Drawing



* In order to comply with Section 4.2.16 of IEC 61496-3, when the OS32C is mounted where the scanner position could change (e.g. as the result of an impact), additional mechanical means, such as serrated or toothed lock washers, must be employed in the mounting hardware.

Fig. 4-22 Dimensional drawing of OS32C with simple mounting bracket OS32C-BKT3

■ OS32C with Simple Mounting Bracket and Top Guard Kit Dimensional Drawing

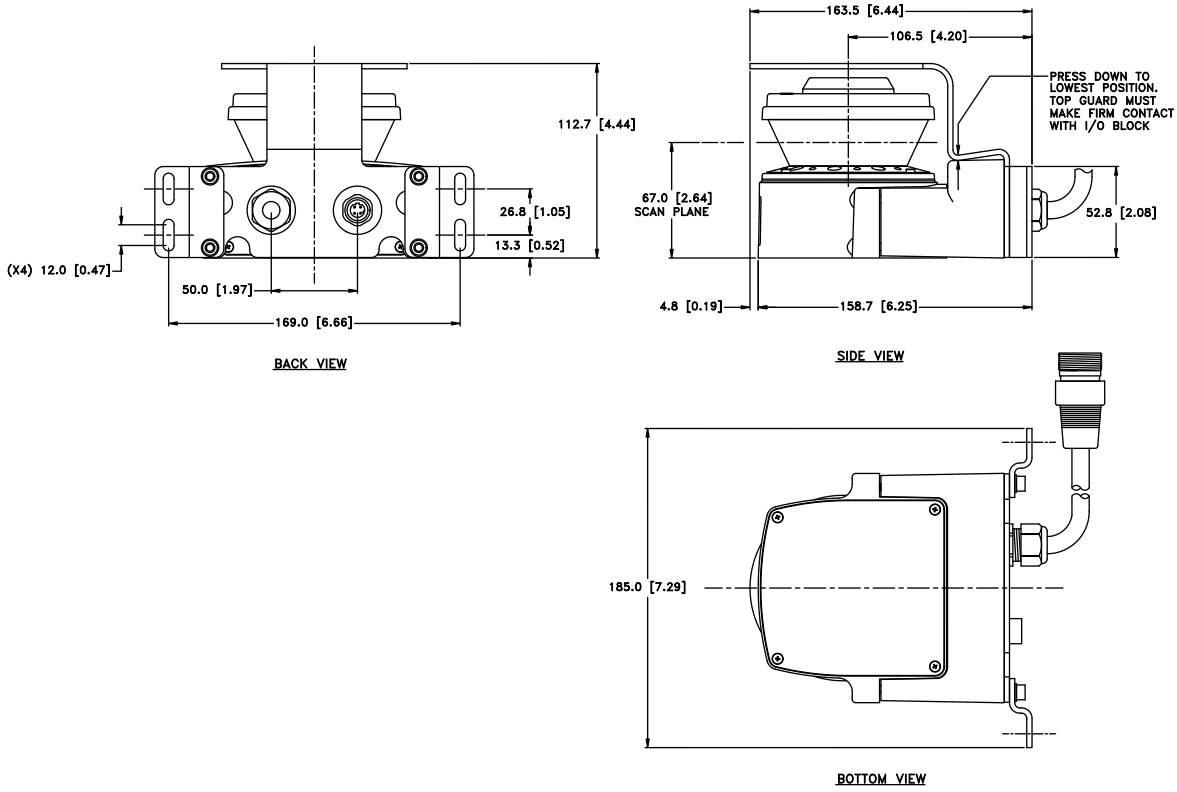
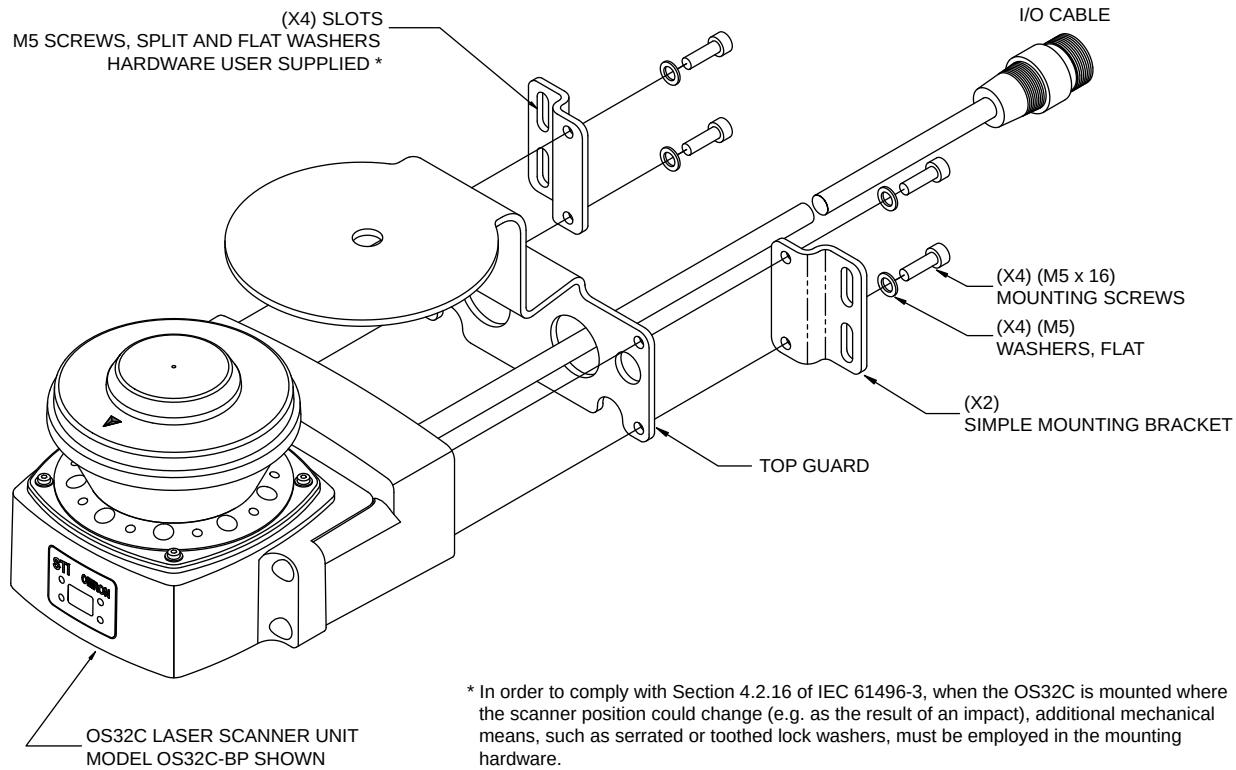


Fig. 4-23 Dimensional drawing of OS32C with OS32C-BKT3 and OS32C-BKT4

■ OS32C with Simple Mounting Bracket and Top Guard Kit Assembly Drawing



* In order to comply with Section 4.2.16 of IEC 61496-3, when the OS32C is mounted where the scanner position could change (e.g. as the result of an impact), additional mechanical means, such as serrated or toothed lock washers, must be employed in the mounting hardware.

Fig. 4-24 Assembly drawing of OS32C with OS32C-BKT3 and OS32C-BKT4

■ OS32C with Bottom/Side Mounting Brackets

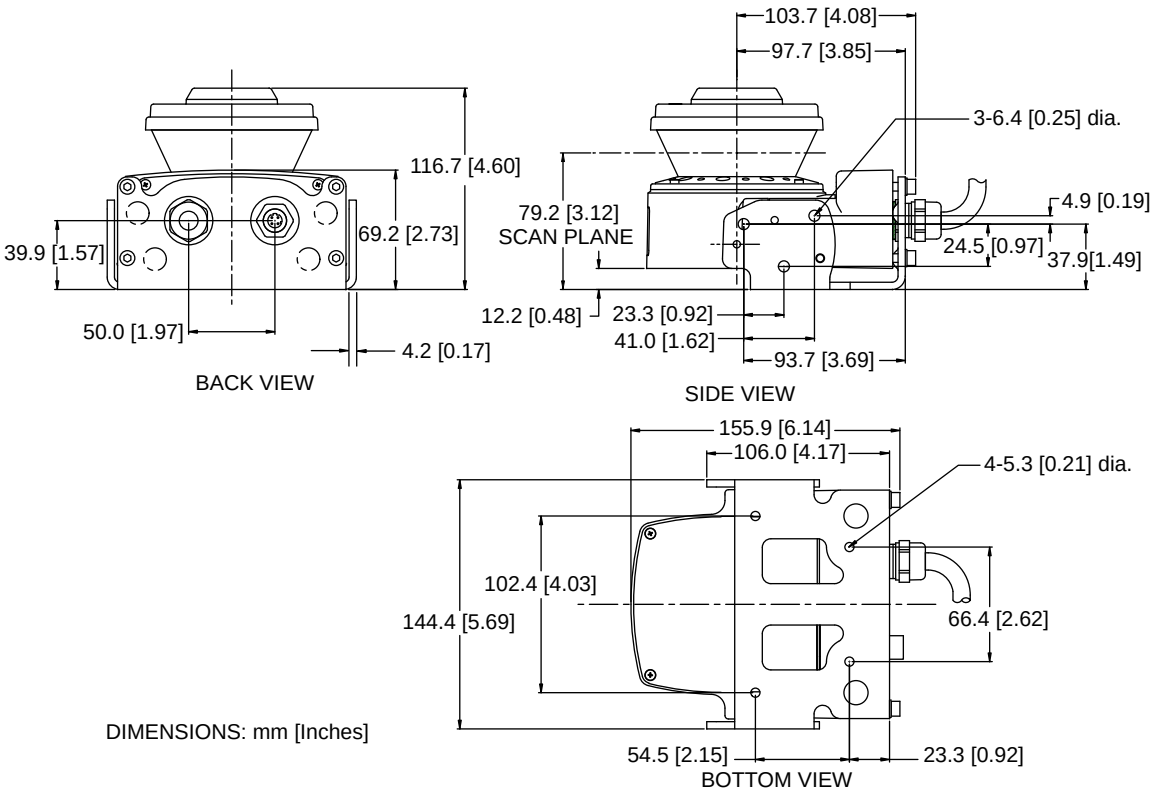


Fig. 4-25 External dimensional drawing of OS32C with OS32C-BKT1

■ OS32C with Bottom/Side Mounting Brackets Assembly Drawing

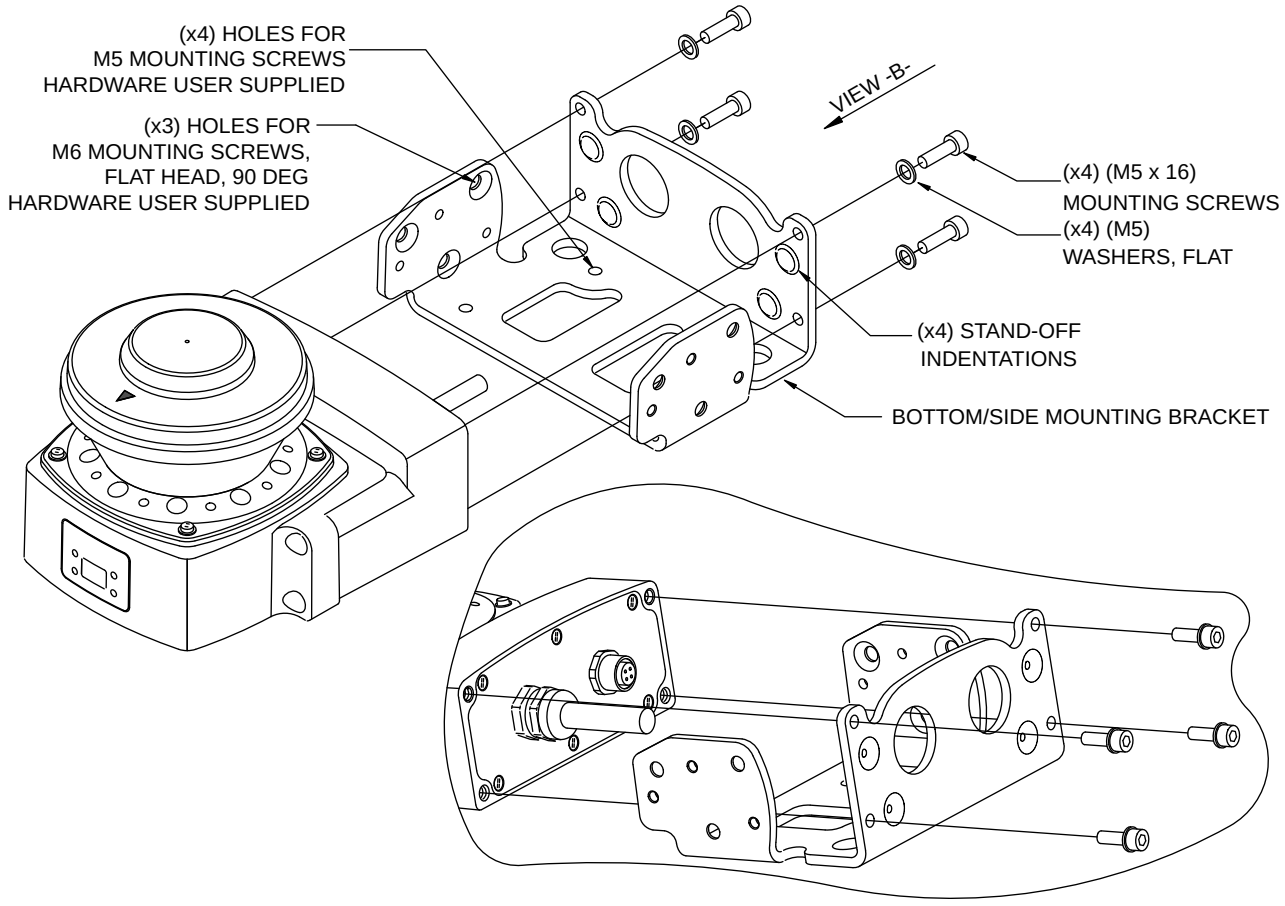
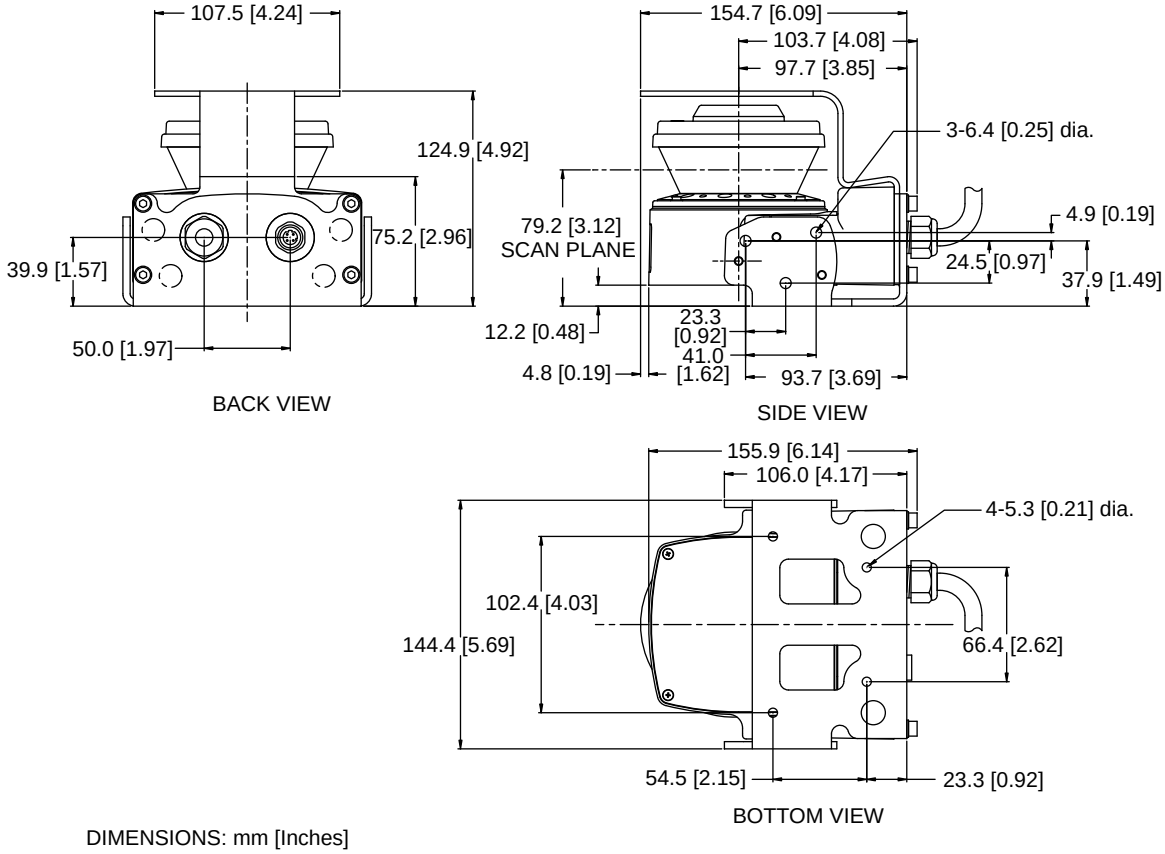


Fig. 4-26 Assembly drawing of OS32C with OS32C-BKT1

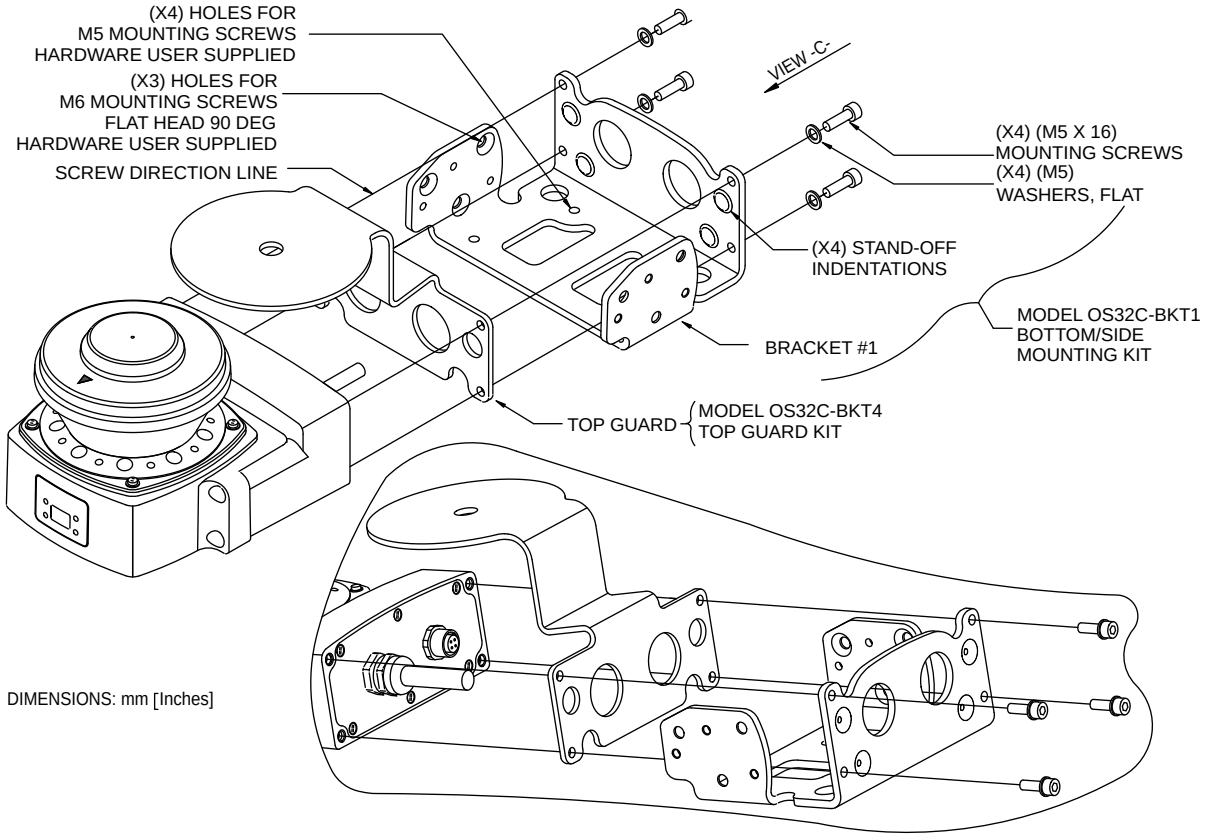
■ OS32C with Bottom/Side Mounting Brackets and Top Guard Kit



DIMENSIONS: mm [Inches]

Fig. 4-27 Dimensional drawing of OS32C with OS32C-BKT1 and OS32C-BKT4

■ OS32C with Bottom/Side Mounting Brackets and Top Guard Kit Assembly Drawing



DIMENSIONS: mm [Inches]

Fig. 4-28 Assembly drawing of OS32C with OS32C-BKT1 and OS32C-BKT4

■ OS32C with XY Axis Rotation Mounting Kit Dimensional Drawing

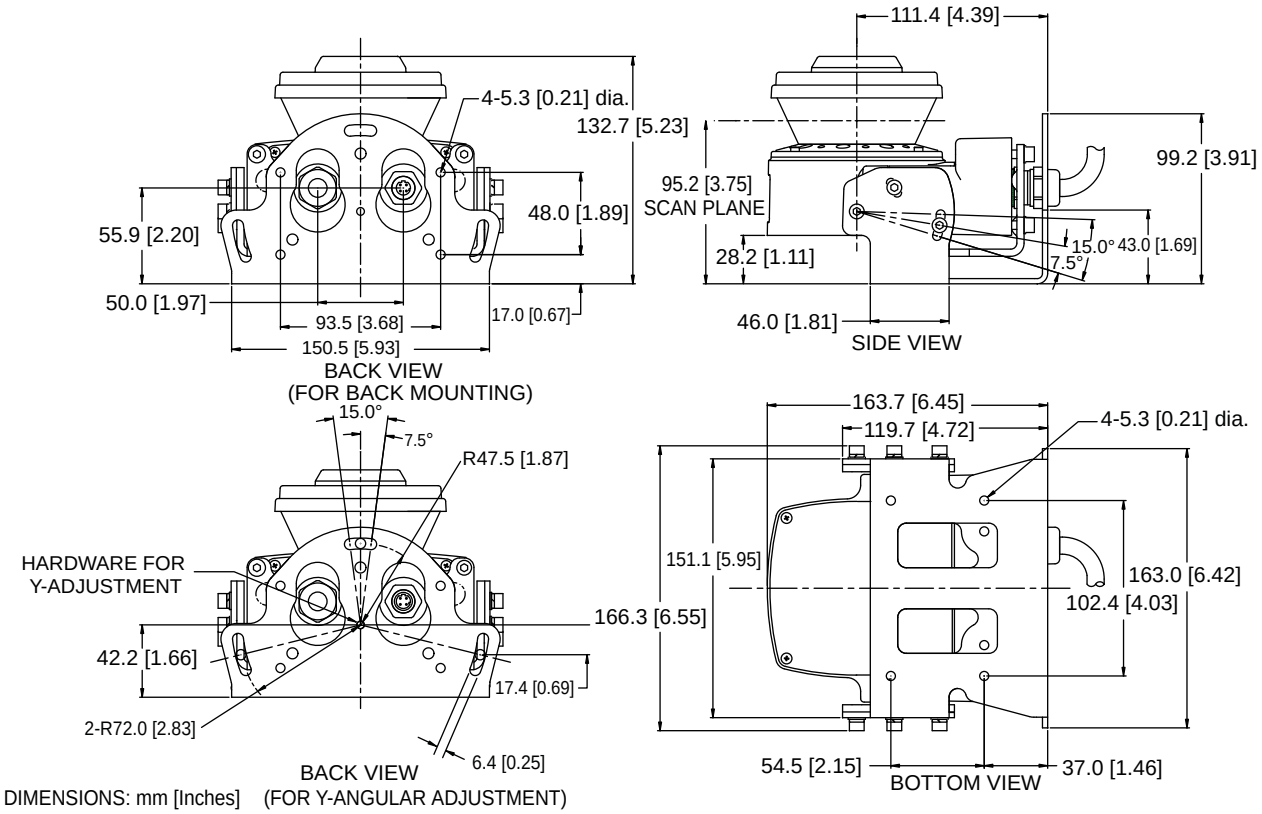
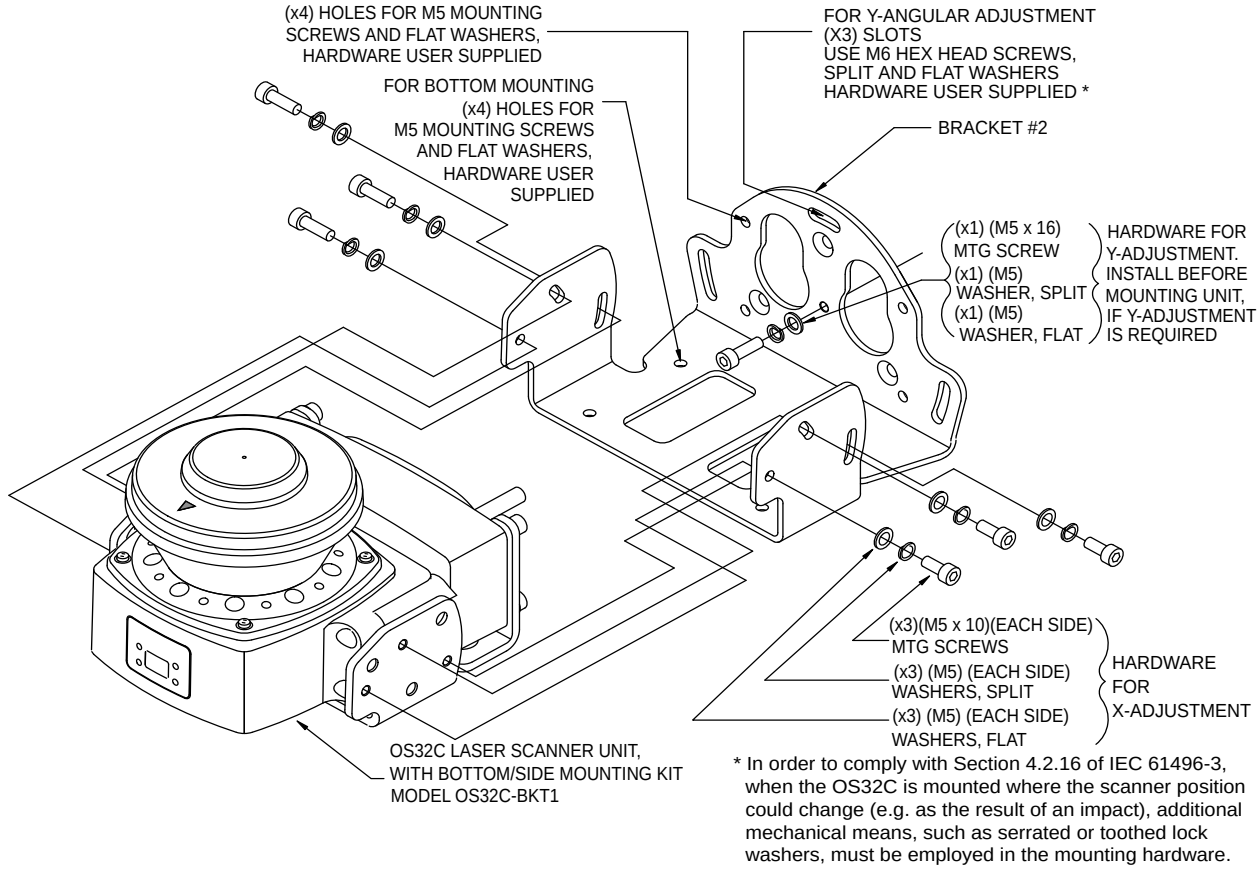


Fig. 4-29 Dimensional drawing of OS32C with OS32C-BKT1 and OS32C-BKT2

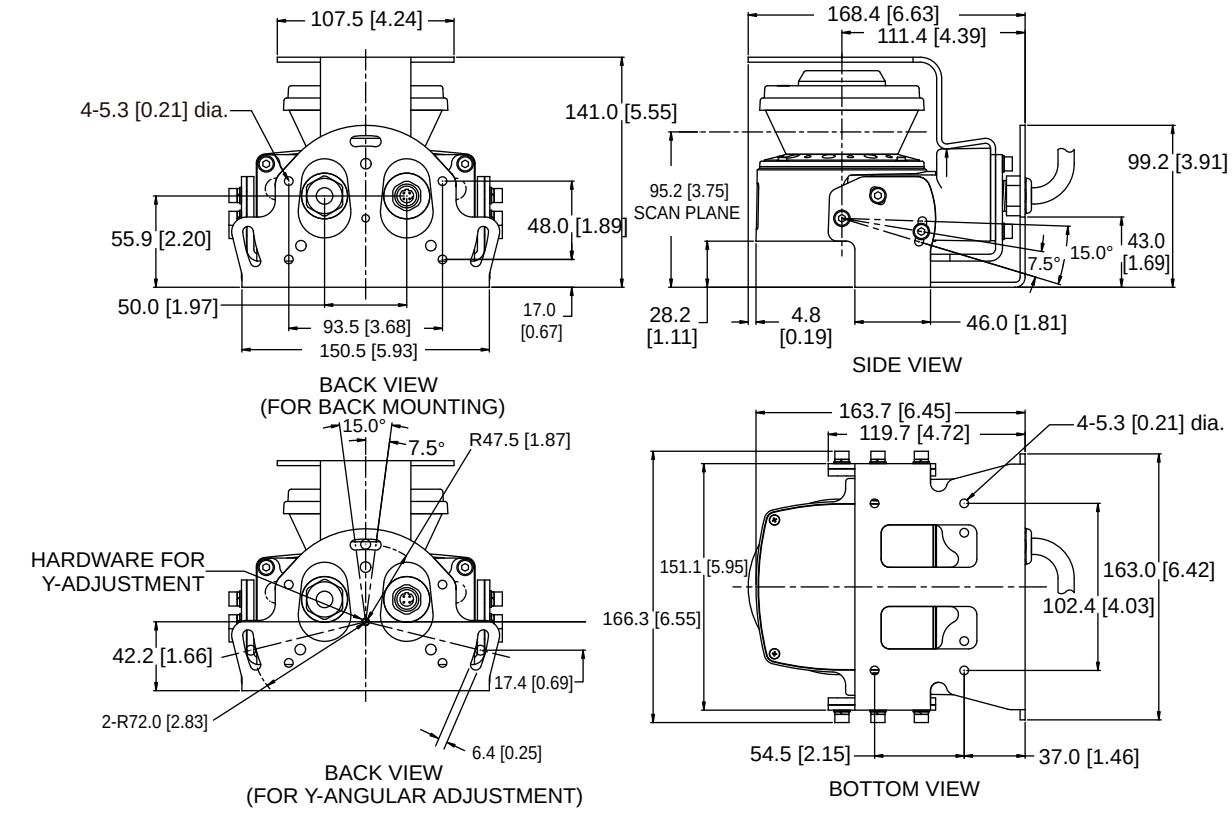
■ OS32C with XY Axis Rotation Mounting Kit Assembly Drawing



* In order to comply with Section 4.2.16 of IEC 61496-3, when the OS32C is mounted where the scanner position could change (e.g. as the result of an impact), additional mechanical means, such as serrated or toothed lock washers, must be employed in the mounting hardware.

Fig. 4-30 Assembly drawing of OS32C with OS32C-BKT1 and OS32-BKT2

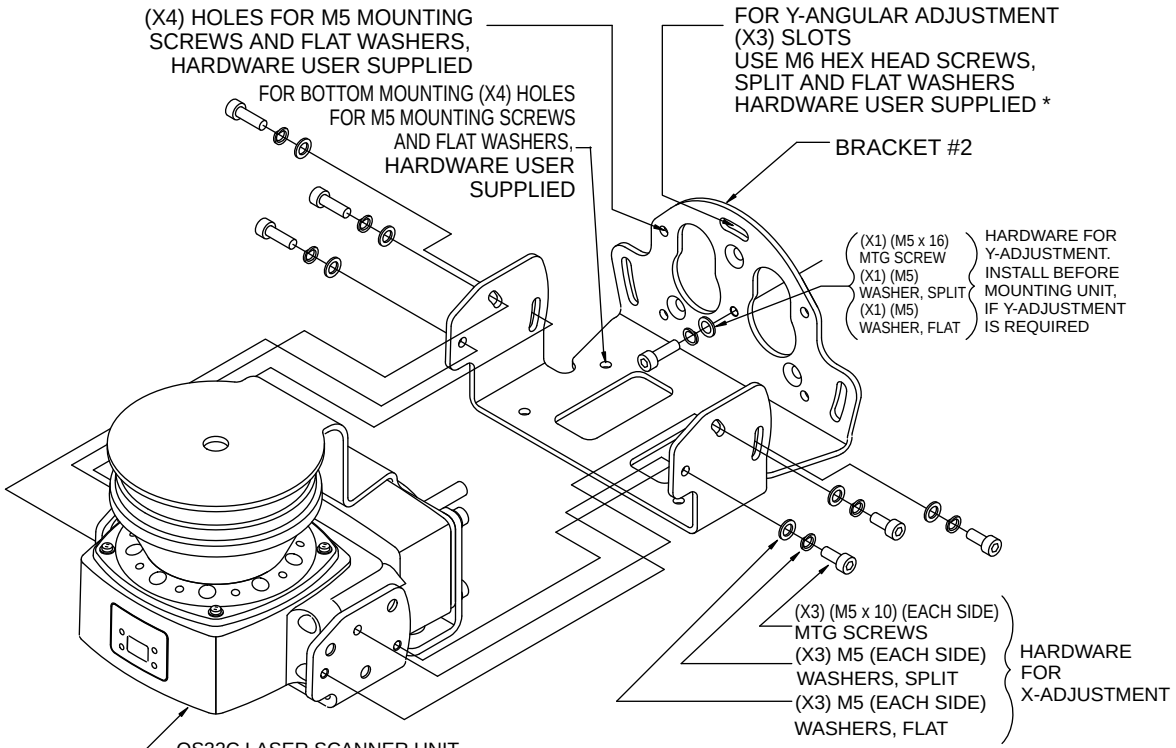
■ OS32C with XY Axis Rotation Mounting Kit and Top Guard Dimensional Drawing



DIMENSIONS: mm [Inches]

Fig. 4-31 Dimensional drawing of OS32C with OS32C-BKT1 and OS32C-BKT2 and OS32C-BKT4

■ OS32C with XY Axis Rotation Mounting Kit and Top Guard Assembly Drawing


(X4) HOLES FOR M5 MOUNTING SCREWS AND FLAT WASHERS, HARDWARE USER SUPPLIED
FOR BOTTOM MOUNTING (X4) HOLES FOR M5 MOUNTING SCREWS AND FLAT WASHERS, HARDWARE USER SUPPLIED
FOR Y-ANGULAR ADJUSTMENT (X3) SLOTS USE M6 HEX HEAD SCREWS, SPLIT AND FLAT WASHERS HARDWARE USER SUPPLIED *
BRACKET #2
(X1) (M5 x 16) MTG SCREW
(X1) (M5) WASHER, SPLIT
(X1) (M5) WASHER, FLAT
HARDWARE FOR Y-ADJUSTMENT. INSTALL BEFORE MOUNTING UNIT, IF Y-ADJUSTMENT IS REQUIRED
(X3) (M5 x 10) (EACH SIDE) MTG SCREWS
(X3) M5 (EACH SIDE) WASHERS, SPLIT
(X3) M5 (EACH SIDE) WASHERS, FLAT
HARDWARE FOR X-ADJUSTMENT
OS32C LASER SCANNER UNIT WITH BOTTOM/SIDE MOUNTING KIT MODEL OS32C-BKT1 WITH TOP GUARD KIT MODEL OS32C-BKT4

* In order to comply with Section 4.2.16 of IEC 61496-3, when the OS32C is mounted where the scanner position could change (e.g. as the result of an impact), additional mechanical means, such as serrated or toothed lock washers, must be employed in the mounting hardware.

Fig. 4-32 Assembly drawing of OS32C with OS32C-BKT1 and OS32C-BKT2 and OS32C-BKT4

■ Mounting Stand

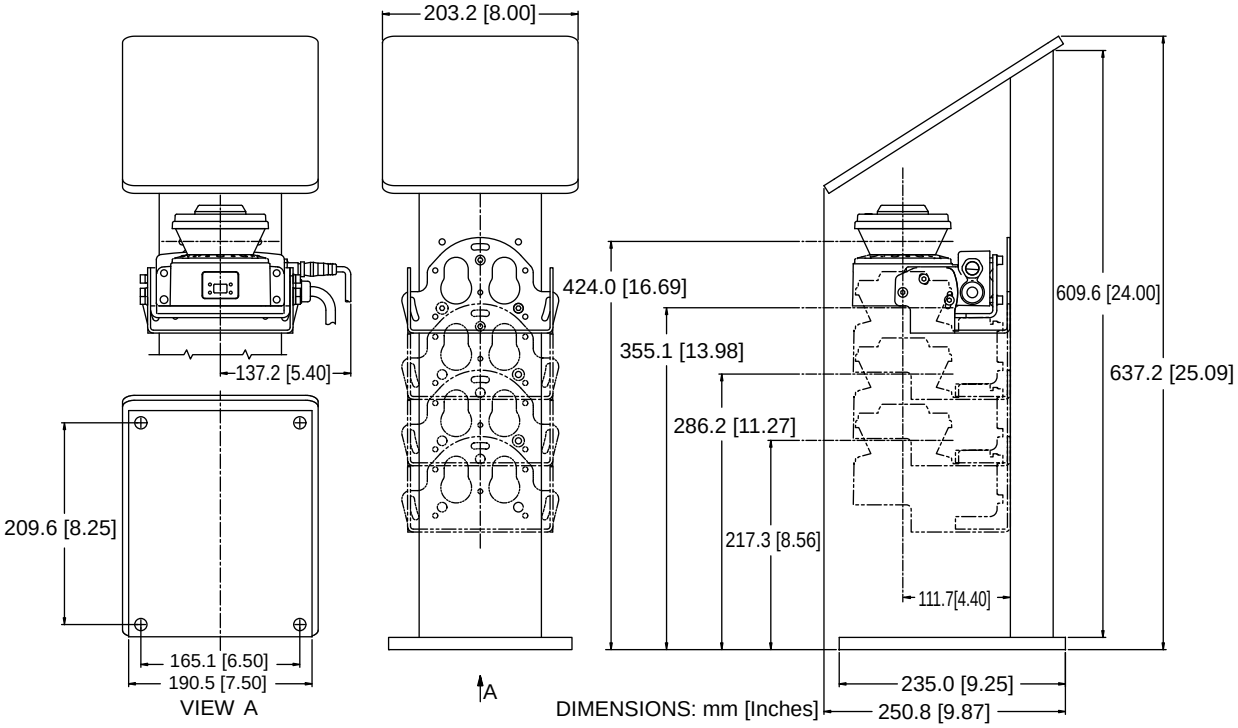


Fig. 4-33 Mounting Stand Kit

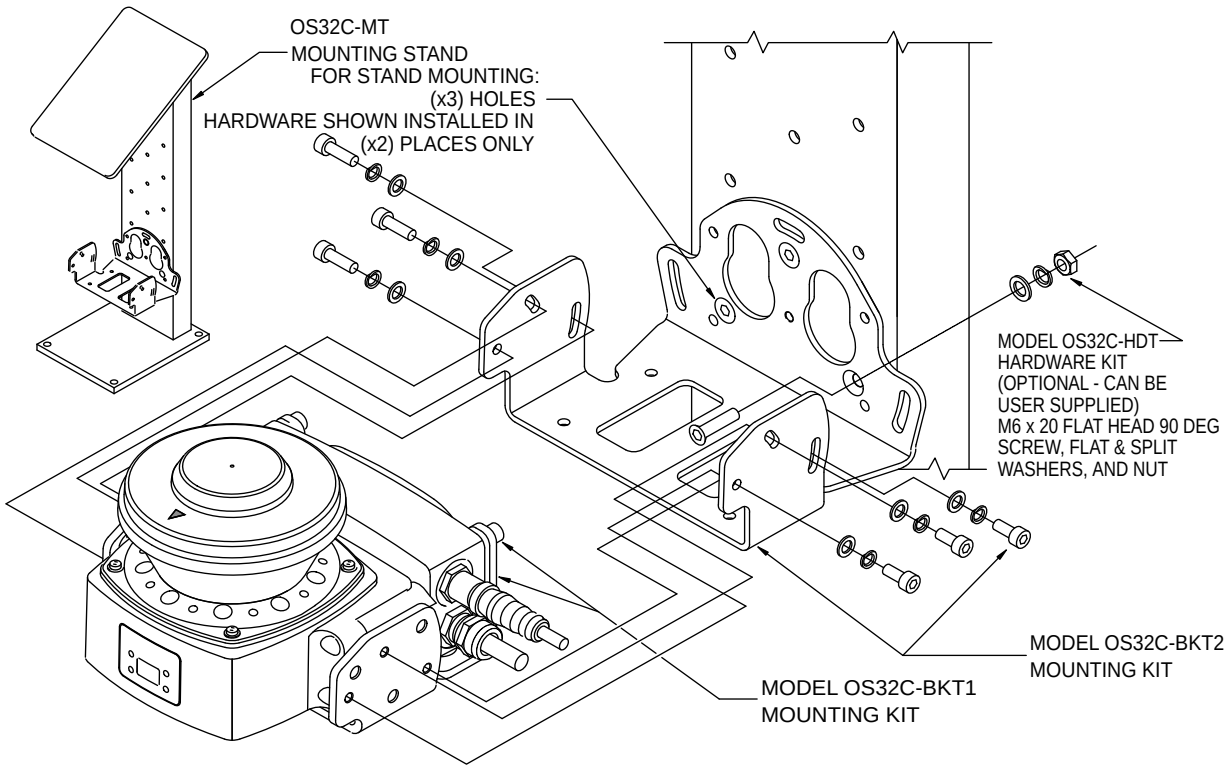


Fig. 4-34 Mounting Stand Assembly OS32C-MT

CHECK!

When using a mounting stand, use an OS32C with side cable entry. The OS32C with back cable entry cannot be used.

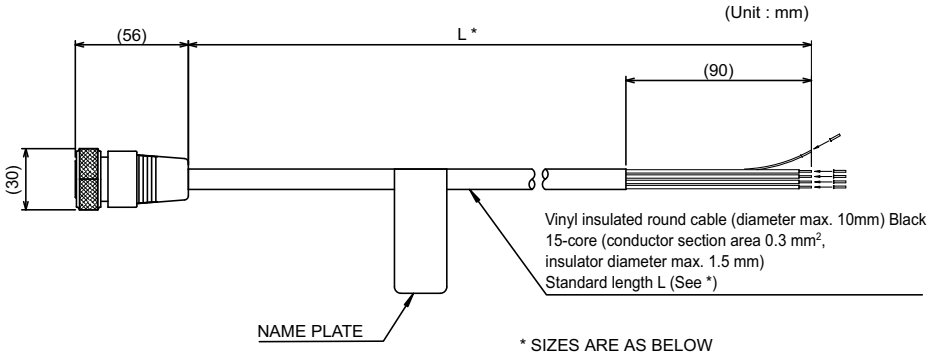
■ Tightening Torque

Refer to table below for tightening torque:

Bolt Diameter	Tightening Torque
M3.5	1.4 N•m
M5	3.4 N•m
M6	3.6 N•m
M8	3.6 N•m

Table 4-1

■ Power Cable

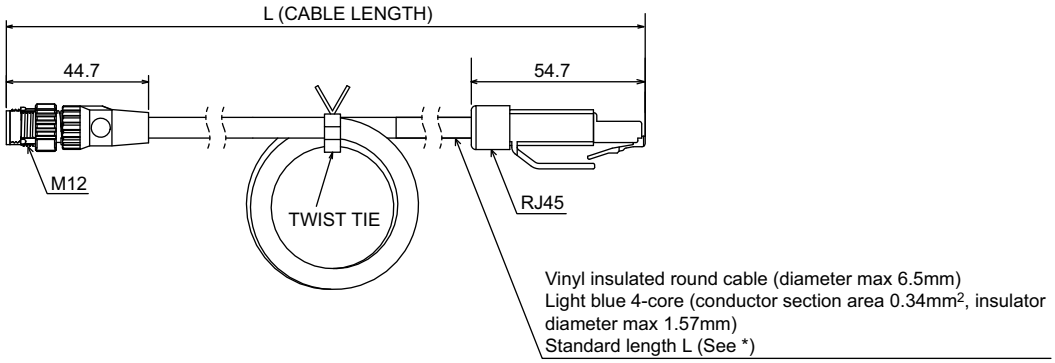


* SIZES ARE AS BELOW

Model Number	Length in m
OS32C-CBL-03M	3m
OS32C-CBL-10M	10m
OS32C-CBL-20M	20m
OS32C-CBL-30M	30m

Fig. 4-35 External dimensional drawing of power cable

Ethernet Cable



* SIZES ARE AS BELOW

Model Number	Length in m
OS32C-ECBL-02M	2m
OS32C-ECBL-05M	5m
OS32C-ECBL-15M	15m

Fig. 4-36 External dimensional drawing of ethernet cable

XS5 OMRON Smartclick™ Connection

■ Connecting the XS5 Plug and Socket

(1) Align the projection on the plug with the polarity key on the socket, then insert the plug all the way in.

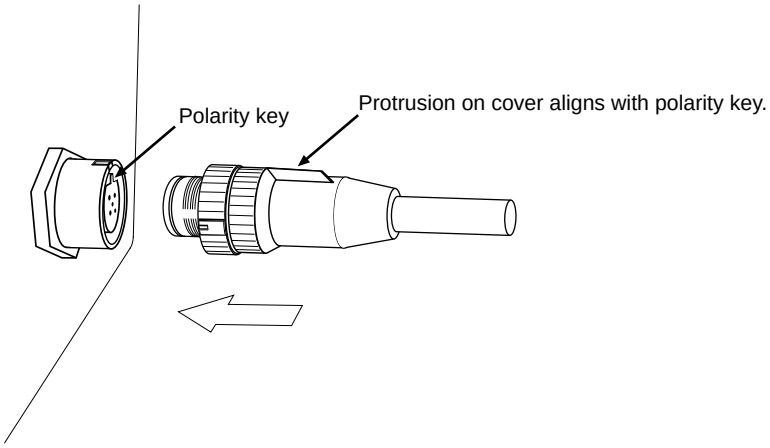


Fig. 4-37 Aligning to polarity key

(2) Hold the knurled grip, then insert the plug into the socket.

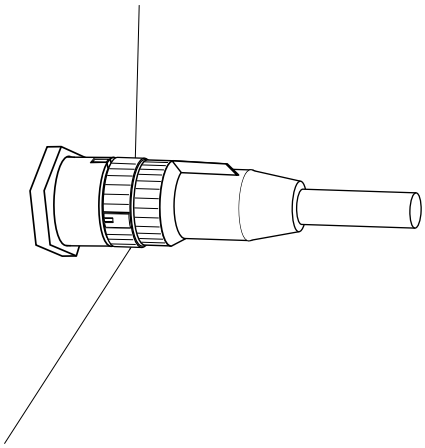


Fig. 4-38 Inserting into the socket

(3) Turn the knurled grips of the plug clockwise approximately 45 degrees.
A click will indicate that the Connectors are locked. The locking condition can also be confirmed by the alignment marks on the plug and socket.

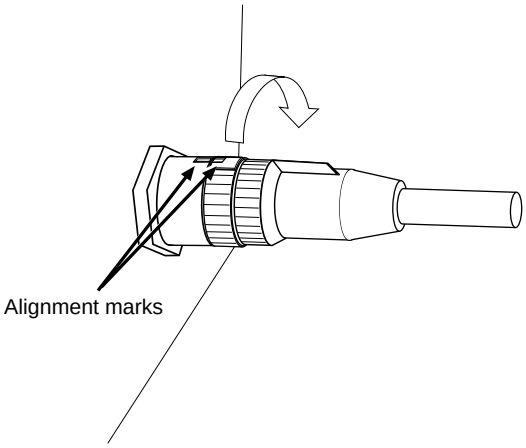


Fig. 4-39 Aligning the XS5 Plug

Chapter5 Wiring

Power Supply Unit	96
Additional Wiring Information	97
Input/Output Signal	98
Example of Safety Circuit	99
Basic Connection with Single OS32C unit	99
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Connecting to the Controller G9SA-301	101

Power Supply Unit

⚠ WARNING

Do not connect the OS32C voltage lines to DC power supplies with more than 30V or less than 16.8 V. In addition, the OS32C should not be connected to AC voltages. Either of the above will result in electrical shock or product malfunction.

For OS32C to meet IEC 61496-1 and UL508, its DC power supply unit must satisfy all of the following conditions:

- •Line voltage rated within (24VDC +25%/-30%)
- •Complying with EMC directives (industrial environments)
- •Double-insulation or reinforced insulation between primary and secondary circuits
- •Automatic return for overcurrent protection
- •Output retention time of 20 ms or longer
- •Satisfying output characteristics requirements of Class 2 circuit or limited voltage/current circuit define in UL508.
- •Power supply complying with regulations and standards of EMC and safety of electrical equipment in a country or a region where the OS32C is used. (Example: In EU, a power supply must comply with EMC directives for low-voltage)

To prevent an electrical shock, use double-insulation or reinforced insulation from hazardous voltage (such as AC230V).

Cable extension must be within a specified length. Otherwise it may result in a failure of the safety functions.

The OS32C can be operated directly using 24VDC +25%/-30%. Operation power of the OS32C must be supplied from dedicated power source. The power source must comply with requirements of IEC 60204-1 and IEC 61496-1.

Additional Wiring Information

⚠ WARNING

Protection of Cable at Installation:
Care should be taken when installing the OS32C cable. The cable must be properly routed and secured to ensure that damage does not occur.

Signal Connector Isolation:
The connectors used during installation must provide sufficient signal separation in order to prevent a short circuit condition of the input power and system signals.

Functional Earth:

The OS32C system requires a functional earth connection.
Do not connect Functional Earth to a positive ground system. If it is connected to positive ground, the guarded machine to be controlled may NOT stop, resulting in severe operator injury.

Input/Output Signal

The tables below reference the connections on the OS32C. They are identified by the pin number, input type, and input name.

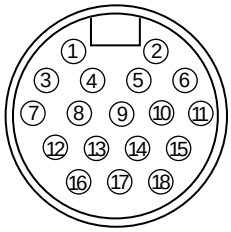


Fig. 5-1 Power Control 18-Pin Mini-Type Connector

The table below cross-references the Power/Control connector pin out and to the mating cable conductor color and signal description.

Connector	Pin	Conductor Colors	Signal Name
18 Pins Mini-Type Connector	1	Orange/White	Zone Select 1
	2	Orange/Black	Zone Select 2
	3	Gray	Zone Select 3
	4	Pink	Zone Select 4
	5	Black	Start
	6	Violet	Standby input
	7	Blue	Auxiliary Output
	8	Red/Black	Warning Output
	9	Red	OSSD A
	10	Yellow	OSSD B
	11	Blue/White	Zone Select 8
	12	White	+24V
	13	White/Black	Zone Select 5
	14	Brown	0V
	15	Brown/White	EDM
	16	Tan	Zone Select 6
	17	Orange	Zone Select 7
	18	Green	Functional earth

Table5-1 Power and Input/Output Connections

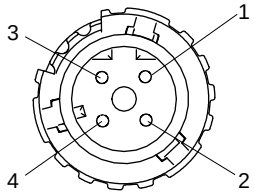


Fig. 5-2 Ethernet Port

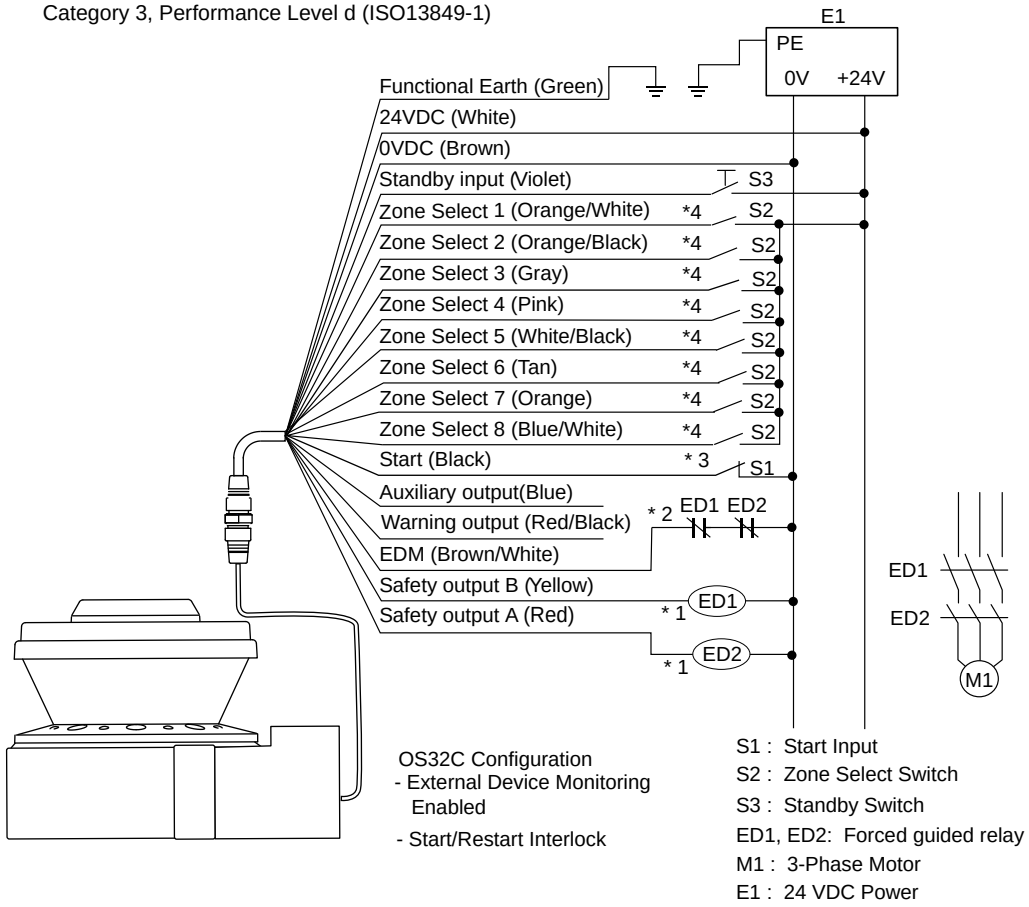
Pin	Signal Name
1	+TX
2	+RX
3	-TX
4	-RX

Table5-2 PC Interface Connections M-12, 4-Pin, Female

Example of Safety Circuit

● Basic connection (with single OS32C unit)

Category 3, Performance Level d (ISO13849-1)



*1. The External Devices ED1 and ED2 are force-guided relays. (e.g. G7Z, G7SA or G7S)
*2. If the External Device Monitoring is not used, connect brown/white wires to 0V, and then turn OFF the External Device Monitoring with the configuration software.
*3. The Start Input must be a Normally Closed switch.
*4. For zone select switch setting, see Zone Set Input Selection.

Fig. 5-3 Basic Connection with Single OS32C unit

CHECK! This wiring example is for category 3.

● Connecting to the AGV Controls

Category 3, Performance Level d (ISO13849-1)

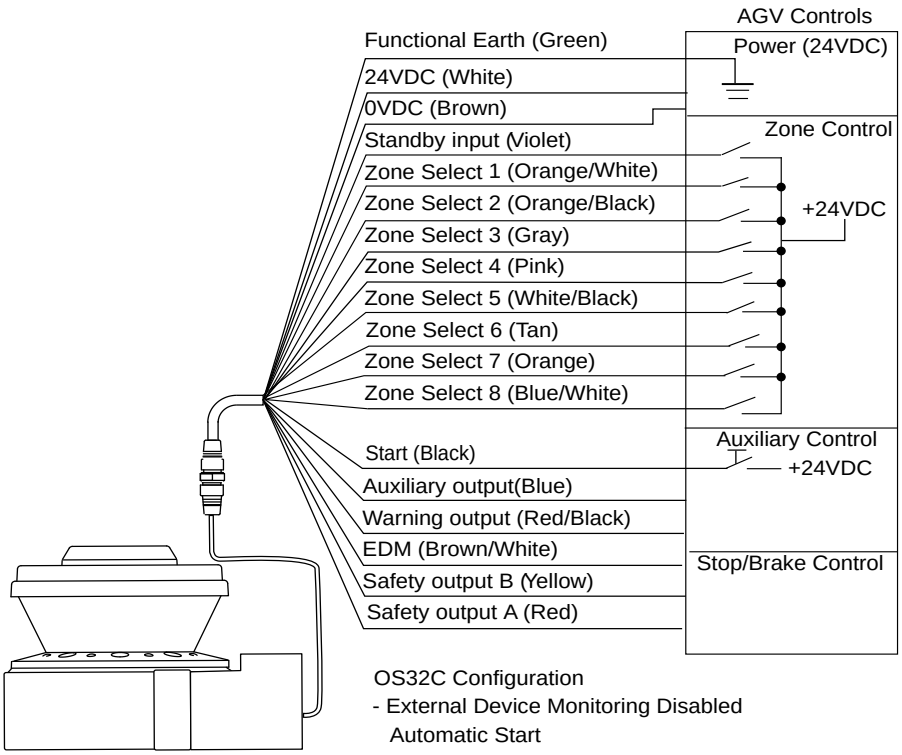


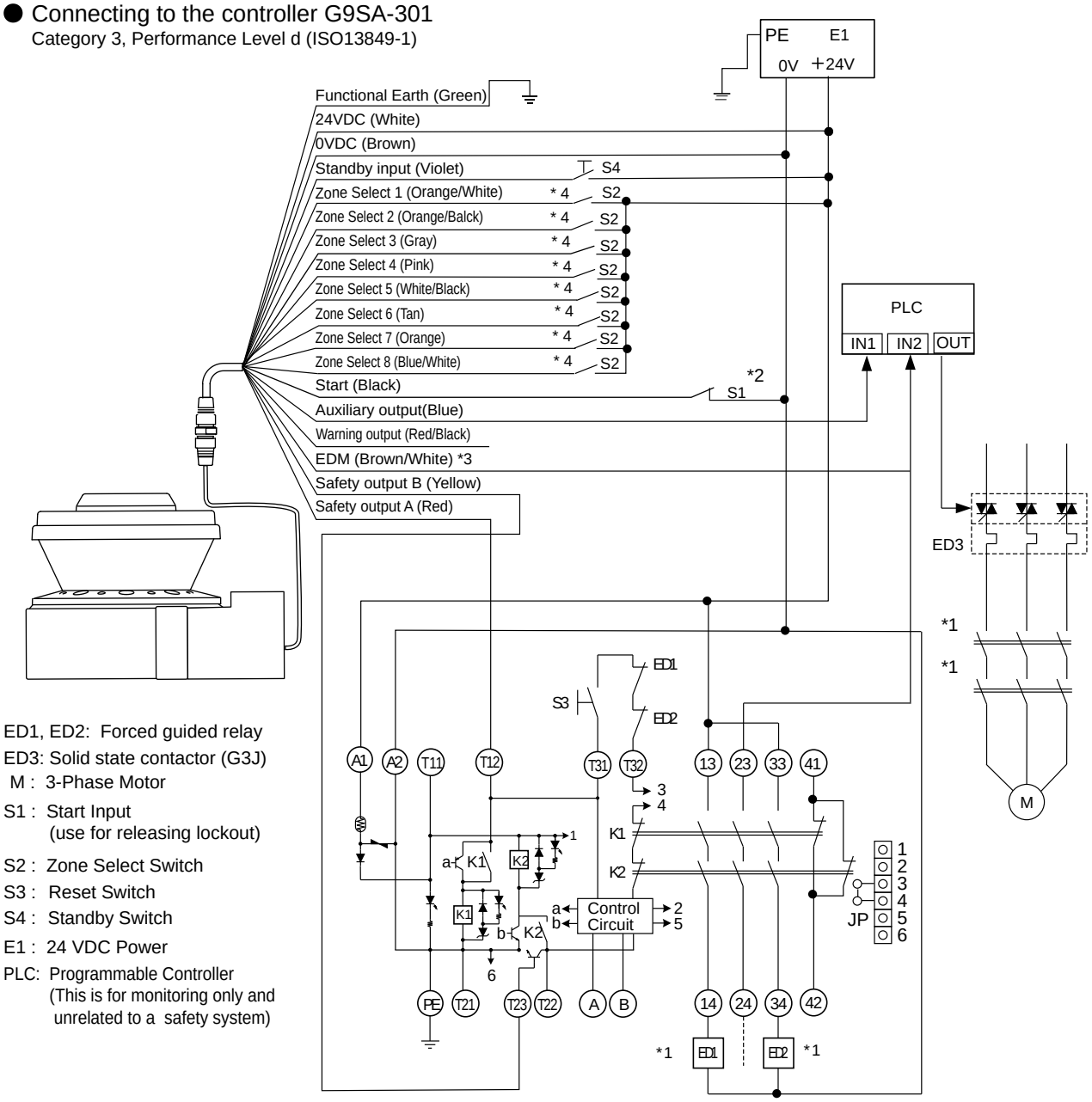
Fig. 5-4 Connecting to AGV Controls

CHECK!

This wiring example is for category 3. In addition, the circuit configuration of the stop/deceleration control must meet the requirements of category 3.

● Connecting to the controller G9SA-301

Category 3, Performance Level d (ISO13849-1)



ED1, ED2: Forced guided relay
ED3: Solid state contactor (G3J)
M : 3-Phase Motor
S1 : Start Input
(use for releasing lockout)
S2 : Zone Select Switch
S3 : Reset Switch
S4 : Standby Switch
E1 : 24 VDC Power
PLC: Programmable Controller
(This is for monitoring only and unrelated to a safety system)

*1. The External Devices (ED1 & ED2) are force-guided relays. (e.g. G7Z, G7SA or G7S)
*2. The Start Input must be a Normally Closed switch.
*3. If the External Device Monitoring is not used, connect brown/white wires to 0 V, and then turn OFF the External Device Monitoring with the configuration software.
*4. For zone select switch setting, see Zone Set Input Selection.

Fig. 5-5 Connecting to the Controller G9SA-301

CHECK! This wiring example is for category 3.

Chapter6 Checkout

Checkout and Test Procedures	104
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Checkout and Test Procedures

⚠ WARNING

The tests outlined in this Test Procedure (See “Checkout and Test Procedure Log” in p.127) must be performed at time of installation, according to the employer's regular inspection program and after any maintenance, tooling change, set up, adjustment, or modification to the OS32C system or the guarded machine. Where a guarded machine is used by multiple operators or shifts, it is suggested that the test procedure be performed at each shift or operation change and also if there is a change in the OS32C operating mode or defined zone sets. Testing ensures that the safety laser scanner and the machine control system are working properly to stop the machine. Failure to test properly could result in serious injury to personnel.

An OS32C system should only be installed, verified and maintained by a qualified person. A qualifed person is defined as *”an individual who understands, is trained on, and demonstrates competence with the construction, operation or maintenance of the machinery and the hazards involved.”* (ANSI/PMMI B155.1-2006)

Checkout and Test Procedures

Refer to p.127 in Appendix for step-by-step instruction and checkout inspection log.

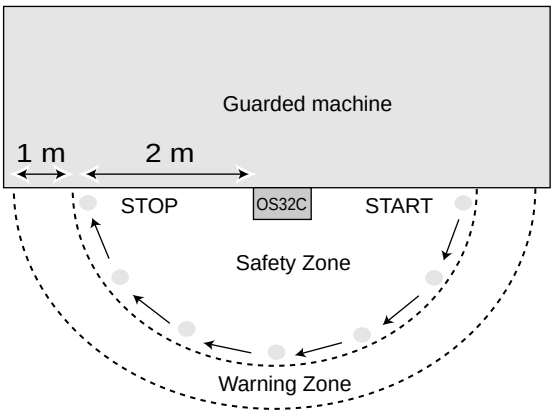
Once the OS32C has been mounted, configured, and properly connected to the machine control system, qualified personnel must perform the Checkout Procedure detailed in the test procedures. A copy of the checkout results should be kept with the records for the guarded machine’s maintenance records.

Testing Safety Zone

⚠ WARNING

If the OS32C is operating in automatic start mode, make sure that the machine stops and not restart when the test object is in the safety zone. Check its operation by approach of a test object into a safety zone. It is recommended that this test be performed after a shift change or 24 hours of operation.

To test the OS32C's detection capability, guide the test object along the perimeter of the safety detection zone as shown in Fig. 6-1. The hazardous motion of the guarded equipment must stop immediately (within the pre-determined accepted stop times). While in Automatic Start Mode, the OS32C MUST remain in the machine stop state throughout the entire test.
To test the OS32C, use a test object with a diameter ranging from 70mm to 80mm. (A test object does not come with the OS32C)



Note:
In this example, a semicircle is configured as 2m of safety zone and 3m of warning zone.

Fig. 6-1 Testing Safety Zone

Verify that all indicators and displays are operating properly and correspond to their defined functions of the OS32C. Inspect the OS32C housing and the exit window for signs of damage or manipulation.

If the OS32C is used in a stationary guarding application, ensure that the safety zone(s) are clearly marked on the floor. For mobile applications, make sure that the vehicle stops moving within the limits set in the initial configuration.

If the OS32C fails any of these tests, lock out the guarded equipment and contact the factory supervisor immediately.

Detection Capability

The OS32C has a minimum Object Resolution of 70mm. This means that the OS32C will detect an object 70mm or larger in diameter that is completely within the field of view.

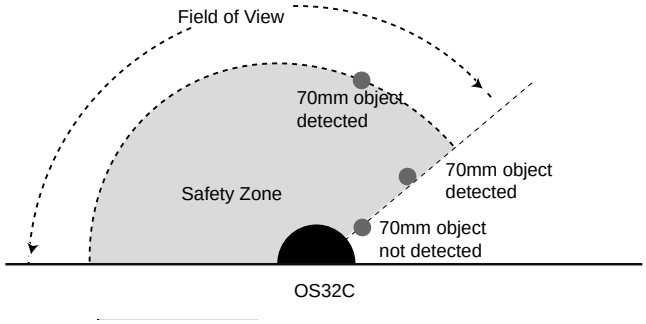


Fig. 6-2 Field of View

Chapter7 Appendix

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Troubleshooting

Troubleshooting

■ Safety output OFF state while there is no intrusion by an object

This may happen due to:

1. Mutual interference

This may happen if light from another scanner (OS32C) or other type of photoelectric sensor such as a safety light curtain, is transmitted into the OS32C. In such a case, install the sensor so that its scanning plane does not receive light from the other sensor.

CHECK! When positioning the OS32C downward, the OS32C may be affected by reflection from the floor surface. Effect of reflection may increase depending on the material of the screen. Be sure to check surrounding environment before installing the OS32C.

For mounting, see Chapter 4 Installation.

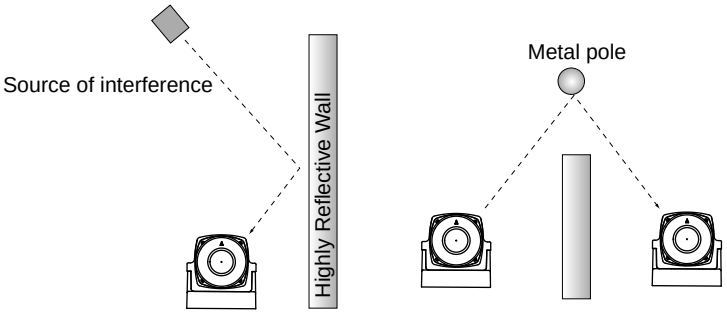

Fig. 7-1

2. Incorrect monitoring zone configuration

A safety zone may have been configured too close to any objects. Since the maximum measurement error of the OS32C is 100mm, the safety zone must be configured at least 100mm away from any objects. An additional measurement error may need to be added due to reflective backgrounds.

Additional Error due to Reflective Background p.114

3. Incorrect zone delay setting

The OS32C will turn OFF if the zone set select input pattern does not fit to any of the patterns configured with the configuration tool within the configured zone delay time. Set the zone delay time to adjust to the specified zone set select input pattern within the given zone delay time.

Zone Set Switching p.24

4. Bright light/Stroboscopic light

Ambient light including high density factory lighting and strobe flash may directly affect the OS32C. An angle of +/-5 degrees must be maintained from the laser scanning plane.

Mounting Considerations p.70

5. Dirty environment

Dirty environment, for instance fog, smoke, steam or other small flying particles may cause the incorrect switching of a Machine Stop state. The influence of the incorrect switching may be decreased if the response time can be increased. To avoid the operation failure, keep the monitoring area clean.

Installation p.69

If the response time is changed, re-calculation of the safety distance is required. This may require re-configuration of the safety zones or re-installation of the OS32C. If the safety distance is not appropriate for the application, the machine may not stop before the hazardous area is reached, resulting in severe injuries.

6. Dirty window

Check if the scan window or dust detection surface (on the base of the window). If the status/diagnostic display shows error code 80, the scan window should be cleaned with a soft cloth.

■ Slow response of the safety output turning ON

This may happen due to unexpected turning OFF of the safety outputs for the reasons described above.

■ Constant Safety Output OFF

1. Dirty window

If the status/diagnostic display shows error code 80, and if the error cannot be reset by cleaning of the scan window, replacement of the scan window may be needed.

CHECK!

Do not put any sealant on the optics cover. If the scan window of the OS32C is replaced, a window calibration needs to be performed by the configuration software. See Chapter 3 Window Calibration.

2. Safety zone layout change

Verify that no objects are intruding in the configured safety zone. If the OS32C is detecting something, the intrusion indicator will turn ON. The configuration software can also be used to monitor the scanning information of the OS32C.

■ If the configuration software cannot receive configuration from the OS32C

1. The communication cable is not properly connected.
   Check connections of the communication cable and the ethernet cable.

2. An OS32C has been set to a fixed IP address and the user loses the address. The user will need to set both the PC and the scanner to DHCP mode so that they can communicate with each other, before the user can set the scanner to a new fixed IP address.

See page 37. to force the scanner into DHCP mode.

■ Configuration Tool was unable to find sensors on the network

(1) Check power and ethernet cables

(2) Check the IP address settings of the PC and the scanner. Make sure both are on the same network.

See Chapter 3: Connecting the PC and the OS32C

■ Communication Time Out

(1) Check power and ethernet cables.

(2) Check the IP address settings of the PC and the scanner. Make sure both are on the same network.

See Chapter 3: Connecting the PC and the OS32C

OS32C Status Check

The OS32C has the status/diagnostic display on the front, which indicates configuration/error status of the OS32C.

■ Diagnostic Codes

Status	Diagnostic Code	Description	Corrective Action
Normal Operation	88	Power up indication	-
	--	Normal operation (guarded machine stop)	-
	- - blinking at a slow rate	Standby mode (guarded machine stop). The rate of blinking depends on the mode.	-
	01	Interlock state (waiting for start input)	-
	02	Configuration mode (guarded machine stop)	-
	80	Window contamination indication (guarded machine stop)	The window is dirty or scratched, clean or replace as necessary
	70	Incorrect number of active zone set select inputs (guarded machine stop)	Check zone set select input wiring, zone configuration selection, zone set select input switching time and zone delay configuration
	71	Invalid or undefined zone set select input combination but correct number of active zone set select inputs (guarded machine stop)	Check zone set select input wiring, zone configuration selection, zone set select input switching time and zone delay configuration
	□□	Table 7-2	-
Safety output fault	30	Safety output fault	Check output connection and wiring.
	32	Safety output A is short-circuited to 24V	
	33	Safety output B is short-circuited to 24V	
	34	Safety output A is short-circuited to 0V	
	35	Safety output B is short-circuited to 0V	
External device monitoring fault	40	EDM (external device monitoring) fault	Check output external device monitoring connection and wiring.
	41	External device monitoring fault before OSSD turning ON	Check the NC-contact status of the external device is changing state before the OSSDs turning ON.
	42	External device monitoring fault after OSSD turning ON	Check the NC-contact status of the external device is changing state after the OSSDs turning ON.
	43	External device monitoring fault during OS32C power on	Check the OS32Cs output configuration,connections and wiring.

Status	Diagnostic Code	Description	Corrective Action
Other fault	50	Affected by noise or disturbance light. Or internal fault.	Check the environment if any noise or disturbance light is coming in. Or consult factory.
	51	Mutual interference	Mounting Considerations p.70
	52	Possible electrical noise interference or internal fault.	Check the environment for electrical noise sources or repair the unit. Or consult factory.
	53		
	54		
	55		
	56		
	57		
	58		
	59	The unit was possibly jarred or bumped.	Check the environment if any jarring or bumping occurs.
	60	Invalid configuration in unit	Reconfigure unit or double check current configuration.
	72	Incorrect number of active zone set select inputs (hard fault code after diagnostic code 70 above persists for more than 10 minutes)	Check zone set select input wiring and zone configuration selection.
	73	Invalid or undefined zone set select input combination, but correct number of active zone set select inputs. (hard fault code after diagnostic code 71 persists for more than 10 minutes)	Check zone set select input wiring and zone configuration selection.
	74	Standby input or zone set select inputs voltage too high	Check zone set select inputs or standby input wired at more than system power (24 VDC).
	75	Scanner chassis connected to power (24 VDC)	Scanner chassis should be grounded to 0 VDC
	82	Window not detected or entire dust detection surface is dirty or blocked.	Check that the window is properly mounted and clean the dust detection surface.
	90	Internal temperature fault	The scanner internal temperature exceeds the operating limit. Add more ventilation.

Table 7-1 Diagnostic Code References

■ Status/Diagnostic Display

The state/diagnostic display indicates a state of the set selection and the response time when of the OSSDs. For example, code 24 indicates zone set 2 with a response time of 160ms.

The response times longer than 400ms are represented by Zero.

Left (2nd Digit)

Monitoring Zone of OS32C	Digital Indication
Zone Set 1	1
Zone Set 2	2
Zone Set 3	3
Zone Set 4	4
Zone Set 5	5
Zone Set 6	6
Zone Set 7	7
Zone Set 8	8
Zone Set 9	9
Zone Set 10	A
Zone Set 11	b
Zone Set 12	C
Zone Set 13	d
Zone Set 14	E
Zone Set 15	F
Zone Set 16 or higher	U

Right (1st Digit)

Response Time (ms) (OSSDs output)		Response Time (ms) (Auxiliary and Warning Output)		Digital Indication	Scan Count
ON to OFF	OFF to ON (Configurable)*	ON to OFF	OFF to ON (Configurable)*		
80 ms	180 ms to 60.08s	120 ms	220 ms to 60.12s	2	2
120 ms	220 ms to 60.12s	160 ms	260 ms to 60.16s	3	3
160 ms	260 ms to 60.16s	200 ms	300 ms to 60.2s	4	4
200 ms	300 ms to 60.2s	240 ms	340 ms to 60.24s	5	5
240 ms	340 ms to 60.24s	280 ms	380 ms to 60.28s	6	6
280 ms	380 ms to 60.28s	320 ms	420 ms to 60.32s	7	7
320 ms	420 ms to 60.32s	360 ms	460 ms to 60.36s	8	8
360 ms	460 ms to 60.36s	400 ms	500 ms to 60.4s	9	9
400 ms	500 ms to 60.4s	440 ms	540 ms to 60.44s	0	10
440 ms	540 ms to 60.44s	480 ms	580 ms to 60.48s	0	11
480 ms	580 ms to 60.48s	520 ms	620 ms to 60.52s	0	12
520 ms	620 ms to 60.52s	560 ms	660 ms to 60.56s	0	13
560 ms	660 ms to 60.56s	600 ms	700 ms to 60.6s	0	14
600 ms	700 ms to 60.6s	640 ms	740 ms to 60.64s	0	15
640 ms	740 ms to 60.64s	680 ms	780 ms to 60.68s	0	16
680 ms	780 ms to 60.68s	720 ms	820 ms to 60.72s	0	17

* Configurable using the Restart Delay parameter

Table 7-2 Status/Diagnostic Display Indication

Additional Error due to Reflective Background

⚠ WARNING

An additional measurement error may need to be added due to reflective backgrounds. See Specifications of additional Errors by Background.

Conditions of Background Influence

The OS32C's measurement precision can be affected by the background reflection of an object.

(1) High-reflective background material or object is present in the scanning plane and within 1.2m beyond the safety zone.
(e.g. acryl panel, stainless steel, reflective tape, mirror)
(2) Low-reflective background material or object is present in the scanning plane and within 1.2m beyond the safety zone.
(e.g. paint-finished equipment)

If any of the conditions listed above apply to your application, an additional error factor (Z_2) should be added to the calculated safety zone size.
M = Result of safety zone calculation from safety distance
Z = Additional safety factors (maximum measurement error), $Z = Z_1 + Z_2$
Z_1 = The OS32C's maximum measurement error (100mm)
Z_2 = Additional Error by Reflective Background

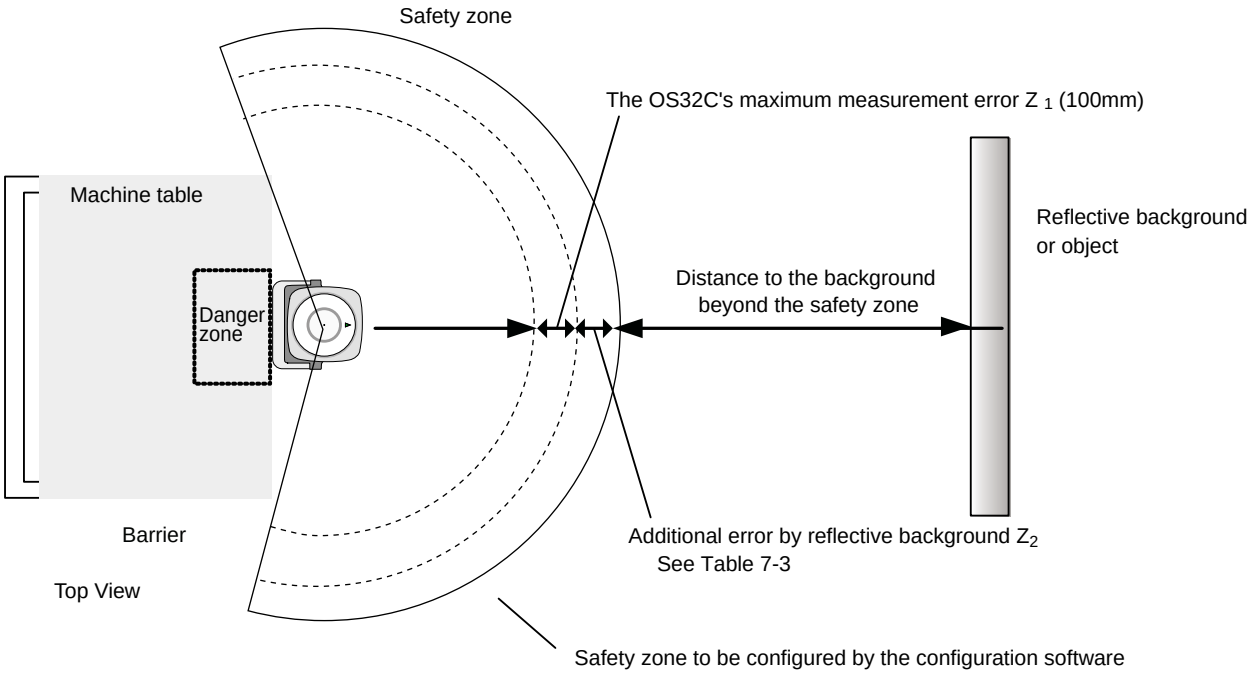
Safety zone
The OS32C's maximum measurement error Z 1 (100mm)
Machine table
Reflective background or object
Distance to the background beyond the safety zone
Danger zone
Barrier
Additional error by reflective background Z2
See Table 7-3
Top View
Safety zone to be configured by the configuration software

Fig. 7-2

Use the following steps to calculate the additional error Z_2 from the safety zone distance M. Take OS32C's measurement error Z_1 and the additional error Z_2 into account to setup safety zone with the configuration software.

■ Procedure

1. Use Table 7-3 to calculate the additional error Z_2 for the safety zone distance M.
2. Measure a distance to a reflective background or object assuming $M+Z_1+Z_2$ as the edge of the safety zone.
3. If the dimension above satisfies the condition (1) or (2), add Z_1 and Z_2 to the value for the safety zone range. If neither condition is satisfied, add Z_1 without adding Z_2.

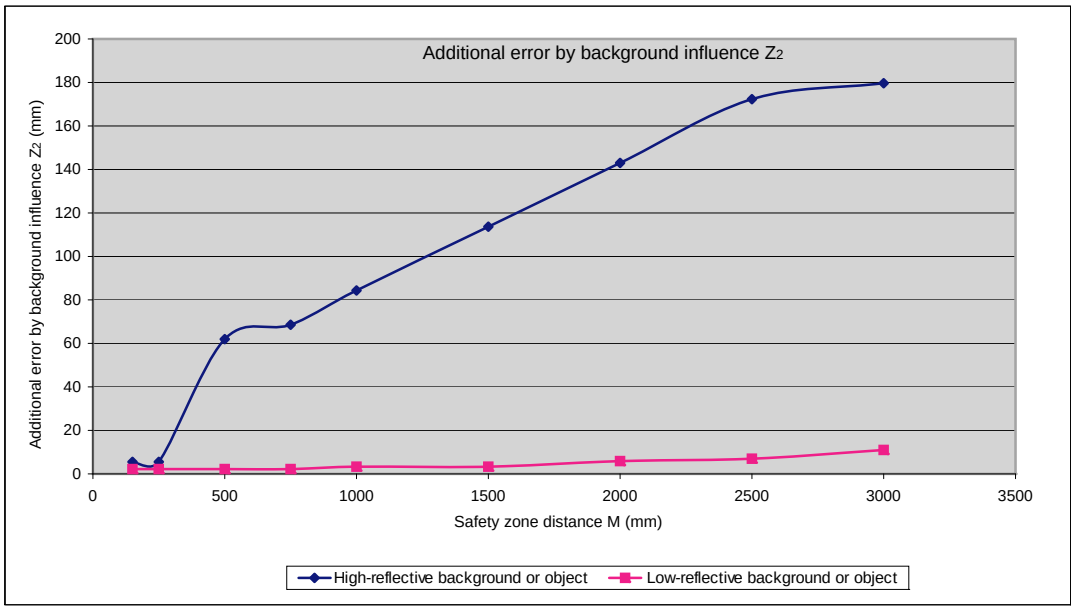

Table 7-3 Additional error by background influence

Using Other Safety Device in Combination

If the OS32C is used for presence detection only, instead of intrusion detection, it is not necessary to take the additional error Z_2 into account. Figures 7-3 and 7-4 show examples using OS32C for presence detection only.

CHECK!

Configure the safety zone with a distance of 100mm or more, taking only OS32C's measurement error Z_1 = 100mm into account.

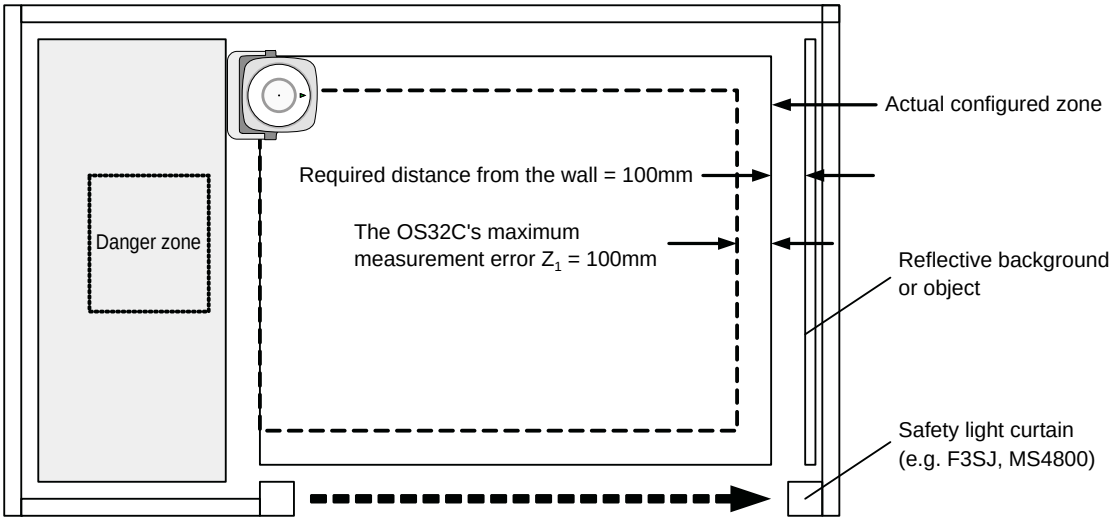

Fig. 7-3 Installing Safety Light Curtain on Entrance

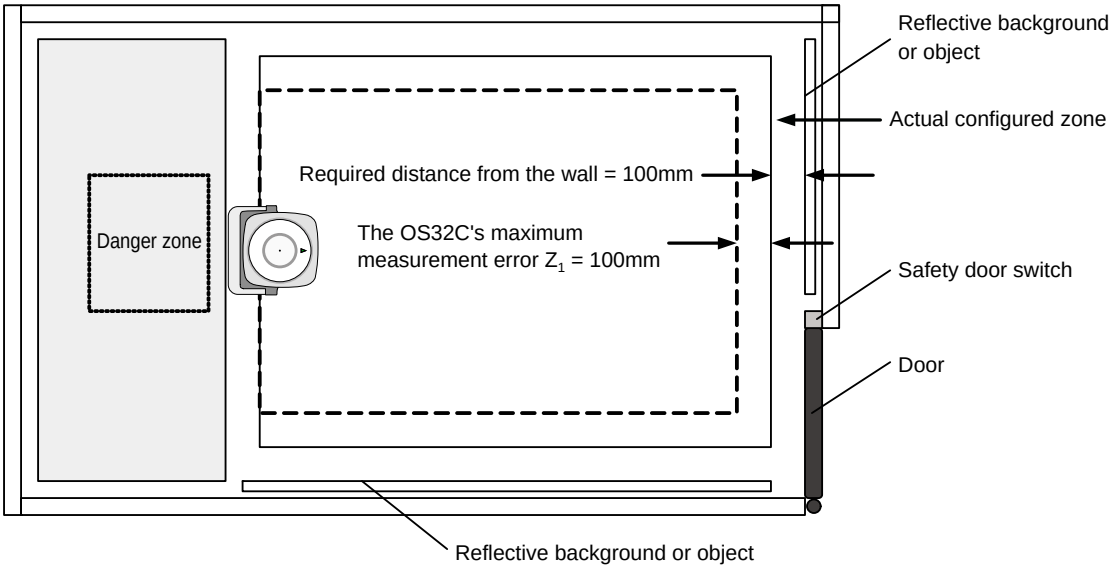

Fig. 7-4 Installing Door on Entrance

Sensor and I/O Block Replacement

⚠ CAUTION

Take precautions to prevent dirt, dust or debris from entering the sensor and I/O block connectors. It is recommended that this be done on a clean workstation as contaminants may degrade the performance of the OS32C.

When either the sensor block or the I/O block is replaced, the Checkout and Test Procedure on page 125 must be performed.

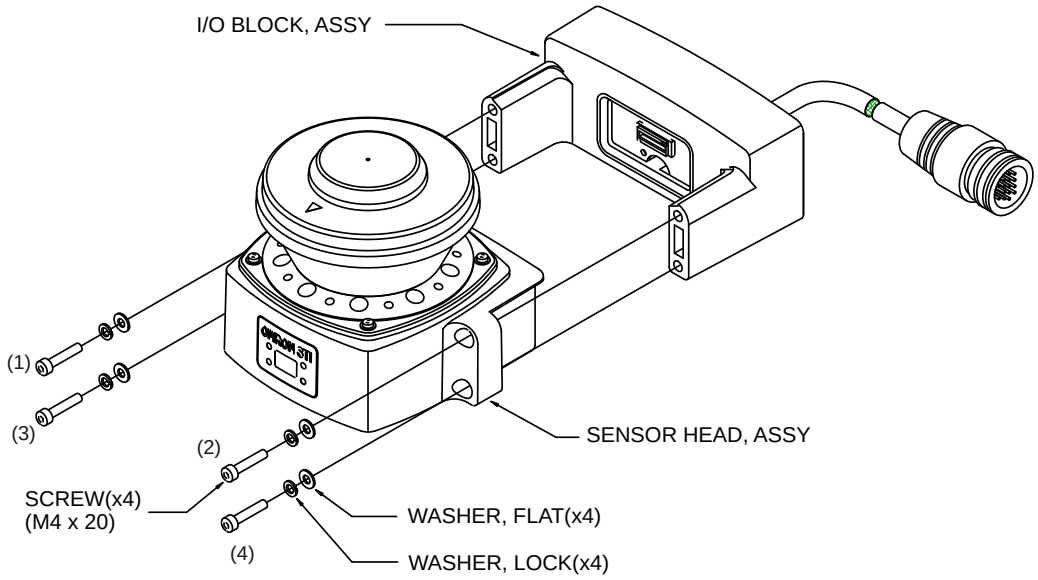

Fig. 7-5 Sensor Block Replacement

CHECK!

Required Tool: 3mm Allen wrench

1. Remove power from the OS32C.
2. Remove the four screws and washers that secure the sensor block to the I/O block.
3. Replace the old sensor block or I/O block with the new one.
4. Replace the four screws with flat and lock washers in an alternating patterns. It is recommended that the screws be tightened to a torque of 1.5 - 2.0 N•m (13.28 - 17.1 in•lb).

Scan Window Replacement Procedure

Window Replacement Procedure

⚠ WARNING

Do not modify the main unit of the OS32C. Do not replace or fix any component of the OS32C other than the ones specified in this manual. Doing so may result in a failure of the safety functions.

If there is any damage to the scan window such as a crack, replace it as soon as possible. Otherwise it may result in a failure of the protective mechanism. Take preventive measures when performing replacement work so that dust does not enter the OS32C.

Always detach all cables from the OS32C before replacing the scan window. Otherwise the motor may start rotating, resulting in injuries.

⚠ CAUTION

Adhesion of dust to the scan window may cause a false operation. The OS32C will require periodic cleaning of the scan window and dust detection surface.

■ Window Replacement Kit OS32C-WIN-KT

Kit contents

•Scan Window	1
•Gasket (pre-installed in window)	1
•Screw for window (M3)	4
•Flat Washer	4

CHECK! Required Tool: 2mm Allen wrench

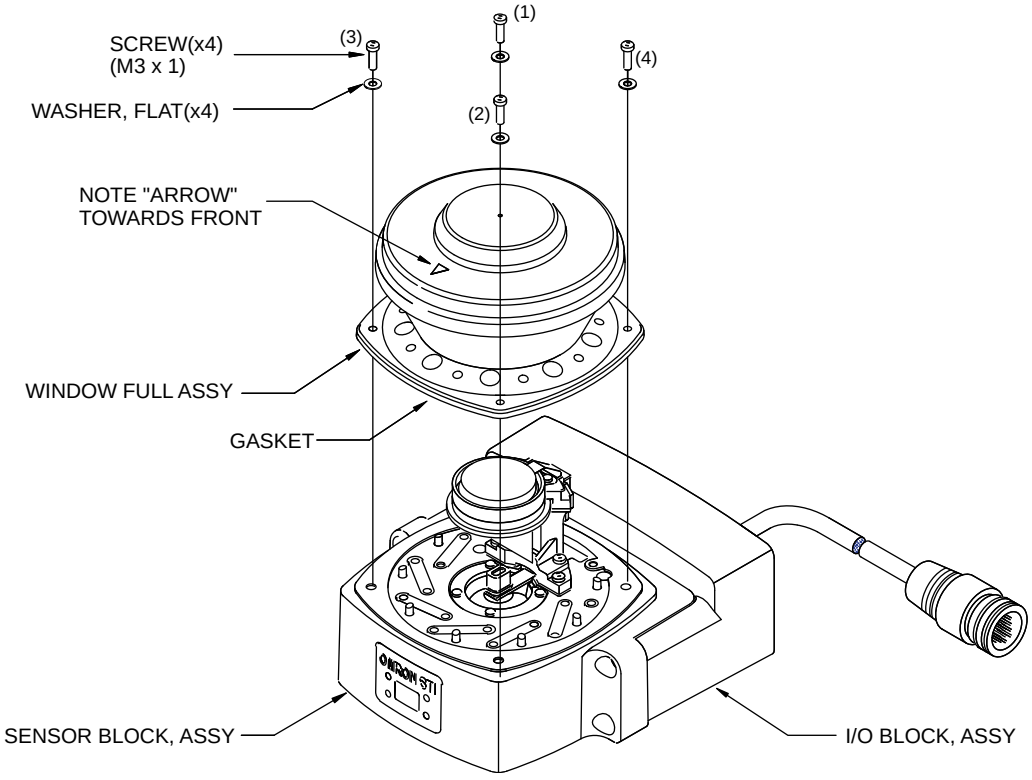

Fig. 7-6 Window Replacement

Window replacement of the OS32C can be accomplished without factory support. Follow the procedure below:

1. Remove power from the OS32C. Remove all the cables connected to the OS32C.
2. Using a clean cotton cloth, gently wipe off any dirt or dust from the front of the unit that may inadvertently enter the internal space of the OS32C while the window is removed.
   (Do not use standard compressed shop air to blow off dust from inside the unit)
3. Remove the four screws and washers on the sides of the window.
4. Remove the existing window by using a small flat-head screwdriver to gently pry up the window's edge.
5. Verify that the gasket is properly seated onto the new window. Gently press around the gasket surface with your thumb. To remove airbone particles from the inside of the unit only use low pressure compressed air that is suitable for optics and sensitive electronics.
6. Install the new window. Make sure the arrow on top of the new window points towards the front of the scanner. Care should be taken to ensure that the inside of the window is clean and free of fingerprints.
7. While applying even pressure to the top of the window, evenly tighten the four screws with flat washers in an alternating pattern (Fig. 7-6). It is recommended that the screws be tightened to a torque of 0.56N•m (5.0 in.• lb).

   CHECK! Excess pressure on the edges of the window may result in cracking of the material.

8. Recalibrate the sensor to the new window.

   Window Calibration p.65

OS32C Maintenance

The OS32C will require periodic cleaning of the scan window and dust detection surface on the base of the window. The interval of the cleanings will depend on the environment in which the OS32C is used. It is recommended that the window be cleaned using a common glass/plastic cleaner. The window should be sprayed and wiped down with a soft cloth to prevent damage to the surface.

Additional Zone Set Switching Strategies

The following information provides additional strategies to specify protection zones that guarantee protection of zone set A when zone set may switch before monitoring of zone set A is no longer required when switching from zone set A to zone set B ($t_{EndZoneA}$). These examples focus on the dangerous area that exists during zone set transitions, limiting the extended protection zone Z_{extra} to only the areas that need it as opposed to a general extension as described in section 2.

The following diagram uses the same example zone set layout as in the example in section 2, Fig. 2-13. Based on transition related timing parameters previously discussed, this diagram identifies the actual remaining danger area during zone set switching (during T_{extend}).

CHECK! The danger area identified in this diagram is only for example, the actual shape of the danger area will vary based on the installation.

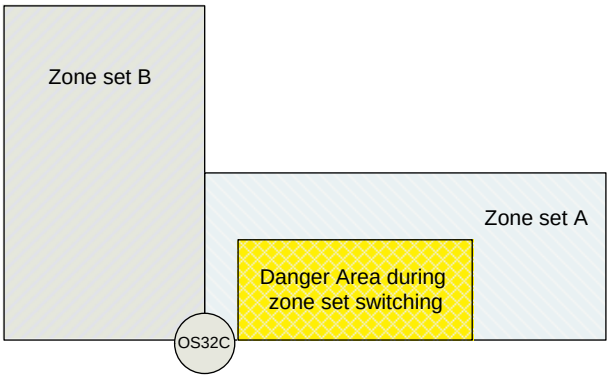

Fig. 7-7 Danger area during zone set switching

There are 3 options for ensuring the Danger Area is adequately guarded during the transition, described in the following examples.

Example 1. Extend Zone Set A Safety Distance relative to the danger area during zone set switching.
In this option, the extra safety distance Z_{extra} is also used to extend Zone set A, but in this case it is only considered relative to the danger area during zone set switching, not the entire monitoring area protected by Zone set A. The resulting zone will adequately protect the danger area during zone set switching, even in the event of zone set switching having completed at t_{min}.

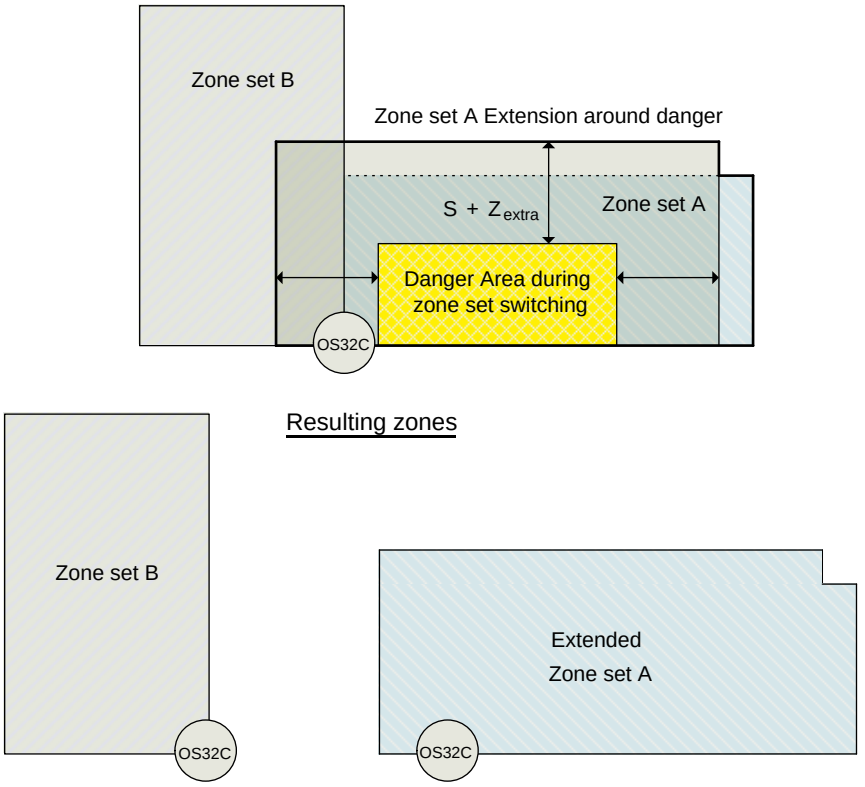

Fig. 7-8 Zone set A extension on limited danger area (example 1).

Example 2. Extend Zone Set B to protect the danger area during zone set switching in Zone Set A.
In this option, no change is made to Zone set A. Instead, the definition of Zone set B is extended to protect the danger area during zone set switching in zone set A. For this expansion, only the normal safety distance to define zone set A should be considered. This solution may not be practical if Zone set A and Zone set B are basically independent, but in cases where Zone set A and Zone set B naturally overlap and/or the danger is due to a device that simply moves from Zone set A to Zone set B, this option may be used.

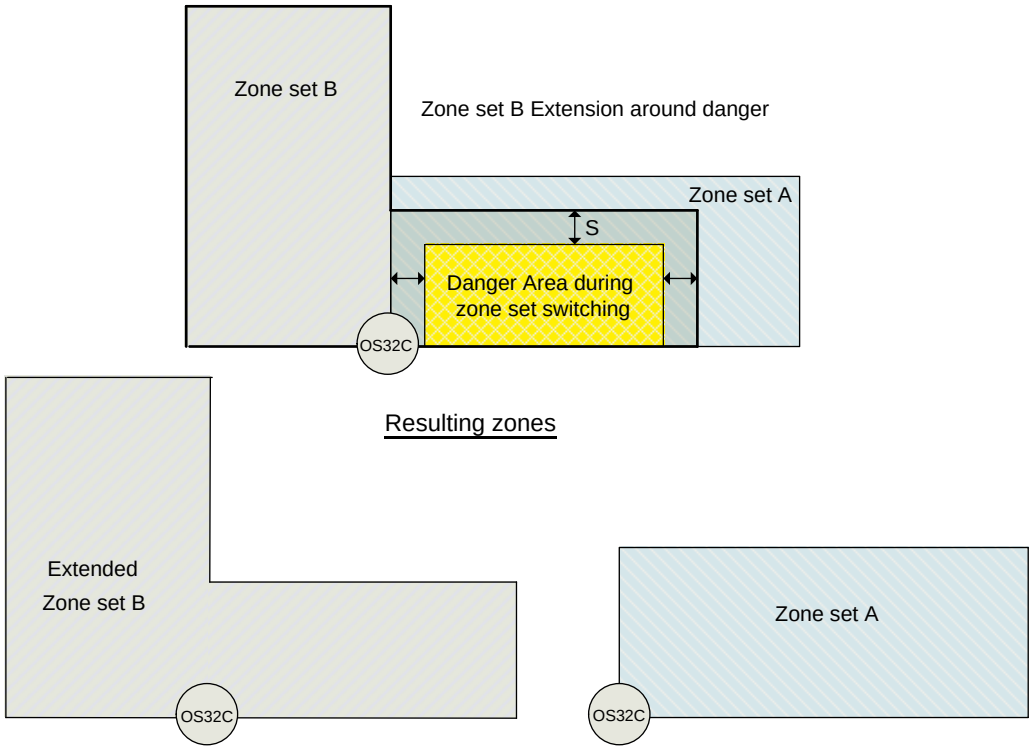

Fig. 7-9 Zone set B extension on limited danger area (example 2).

Example 3. Create a third zone specifically for relaying the transition.

A third zone set (in the following diagram, Zone set C) is defined that is the combination of both Zone set A and Zone set B. Using this mechanism, the zone set change is achieved by first changing from Zone set A to Zone set C (which effectively begins monitoring Zone set B while continuing to monitor Zone set A) and then changing from Zone set C to Zone set B. This allows the timing of the two different zone set switches to be more flexible and easier to design.

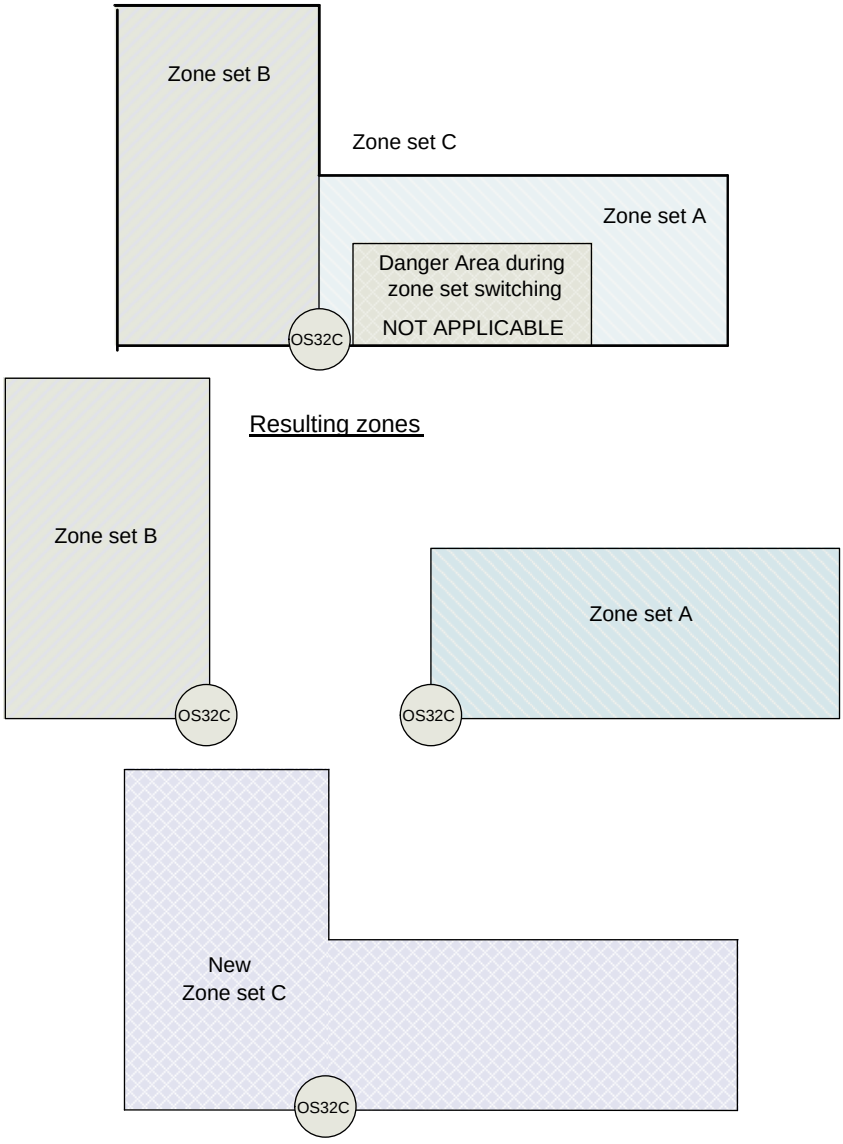

Fig. 7-10 The third zone set that relays switching (example 3).

The first switch (Zone set A to Zone set C) should be setup to meet the same criteria defined previously for specifying t_{start} relative to $t_{DangerZoneB}$, in this case $t_{DangerZoneC}$.

The second switch (Zone set C to Zone set B) should be setup so that $t_{EndZoneA}$, which is relative to the first switch, is guaranteed to be earlier than t_{min} relative to t_{start} of this second switch.

Glossary

Term	Definition
Automatic Start	An object entering the safety zone turns the OSSDs OFF. Once the safety zone is clear, the sensor will automatically enter the safety output ON state.
Auxiliary Output	This is a non-safety output. It may be configured to provide safety output information or lockout information.
Edit Monitoring Zones	When enabled the edit zones mode will allow the current configurations of the safety and warning zones to be modified. The monitoring zones are graphically displayed for editing. This feature can only be used with an access log-on level of supervisor user or higher.
External Device Monitoring	The function to detect a fault, such as the welding of the NC-contacts of the machine's primary control element.
Interlock	OSSD OFF status is maintained until safety is ensured and the start input is applied.
Lockout	A failure is detected and the guarded machine is stopped. The OS32C system will remain in the lockout state until the problem is corrected and a start input is applied.
Monitor Mode	In this mode, the continuously measured data from the OS32C is displayed on the screen in real-time.
Monitoring Zone	The cumulative area of the safety and 2 warning zones.
Monitoring Zone Set	There are 70 selections for this property. A user can select a zone set in the zone set configuration window.
Non-Safety Critical Parameters	These are settings that are not related to the safe installation of the OS32C: Auxiliary output, warning output, restart delay, and standby mode.
Offline Mode	A user can create, edit, and save a configuration to a PC without connecting to the OS32C. The loading and editing of existing configurations on the PC can be done offline as well.
Operator Access Level	This access level cannot change the OS32C settings. Only verification and monitoring of the existing configuration information is available. Password input is not required.
OSSD (Output Signal Switching Device)	This provides ON output when no object is interrupting the sensor in the safety zone. It is used for safety applications.
Reference Boundary Monitoring	When activated, the scanner will monitor the boundary of a given detection zone (safety or warning). The detection zone will be considered violated if the boundary range requirements are not within a certain tolerance.
Response Time	The maximum time between the actuation of the sensor function and the switching of the safety outputs of the OS32C. The response time ranges from 80ms (2 scans) to 680ms (17 scans), in increments of 40ms.
Safety Critical Parameters	These are the settings that configure the safe installation of the OS32C: External device monitoring, response time, operating mode, zone set selection, zone set select input combos, zone transition delay, and reference boundary monitoring.
Safety Zone	A user-defined protection area to which intrusion of an object stops the guarded machine. When an object enters this area, the safety outputs of OS32C turns OFF within a predefined response time. This zone is a safety-critical property.
Sculpting	Within a scanning range of OS32C, a position where closest to OS32C can be automatically configured as a zone. A distance subtracting 100mm from that to an object is configured.
Start	If start interlock or restart interlock is configured, applying the start input releases the interlock state. It can be also used to release lockout.
Start Interlock	After OS32C is started, the interlock state is maintained. Once the interlock is released by the start input, an object entering the safety zone shall turn OSSD OFF. Once the safety zone is clear, the sensor will automatically enter the safety output ON state.
Start/Restart Interlock	After the OS32C is started, the interlock state is maintained. After the interlock is released by the start input, an object entering the safety zone shall turn OSSD OFF and the interlock state is maintained.
Supervisor Access Level	To log on to the configuration software with this access level, a password is required. This access level allows a user to edit OS32C configuration information and send it to the OS32C.
Warning Zone	When an object enters the warning zone, warning zone infringed will be reported. This zone allows for a larger scanning area than the safety zone and can be used to activate a warning function. This zone is a non-safety-critical property.

Term	Definition
Window Contamination Warning	This output can be assigned to the warning output and will turn ON when contamination of the scan window reaches a certain level.
Window Calibration	This is required for replacement of the window. Window calibration resets the threshold value of window transmittance. This threshold value is used for Window contamination warning.
Zone Set Select	Up to 70 zone sets can be switched according to the wiring for zone set selection. Refer to "Zone Set Selection" on page 19.

Accessories

Description	Model
Complete OS32C Systems	
OS32C laser scanner with cable access from the back	OS32C-BP
OS32C laser scanner with cable access from the left side	OS32C-SP1
Spare OS32C Sensor Block	
OS32C spare sensor without I/O block	OS32C-SN
Spare OS32C I/O Blocks	
Spare I/O block with cable access from the back	OS32C-CBBP
Spare I/O block with cable access from the left side	OS32C-CBSP1
Power Cables	
3m cable for power and I/O	OS32C-CBL-03M
10m cable for power and I/O	OS32C-CBL-10M
20m cable for power and I/O	OS32C-CBL-20M
30m cable for power and I/O	OS32C-CBL-30M
Ethernet Cables	
2m cable for scanner configuration	OS32C-ECBL-02M
5m cable for scanner configuration	OS32C-ECBL-05M
15m cable for scanner configuration	OS32C-ECBL-15M
Mounting Brackets	
Bottom/Side Mounting Bracket	OS32C-BKT1
XY Axis Rotation Bracket (must be used with OS32C-BKT1)	OS32C-BKT2
Simple mounting bracket	OS32C-BKT3
Protective cover for window	OS32C-BKT4
OS32C mounting stand (for use with OS32C-SP1) *1	OS32C-MT
OS32C hardware kit to mount BKT1, BKT2, BKT3 to OS32C-MT *2	OS32C-HDT
Miscellaneous	
Window replacement kit	OS32C-WIN-KT
Printed user manual English(paper)	OS32C-MANUAL-EN
Printed user manual Japanese (paper)	OS32C-MANUAL-JP
Spare CD (Configuration Tool + user manual)	OS32C-CD

*1 When using a mounting stand, use an OS32C with side location cable entry. The OS32C with back location cable entry cannot be mounted. Use with XY axis rotation bracket (OS32C-BKT2).

*2 Use this when mounting a bracket to the mounting stand.

Checkout and Test Procedure Log

The following test procedure must be performed by qualified personnel:

- during initial OS32C system installation
- after any maintenance, adjustments or modifications to the OS32C or the machine it is guarding
- at least every three months or more frequently depending on machine usage and employer guidelines

Testing ensures that the OS32C system and machine control system work together to properly stop the machine. **Failure to properly test the equipment could result in serious injury to personnel.**

⚠ WARNING

If the safety system or the machine fails any of these tests, do not run the machine. Immediately tag or lock out the machine to prevent its use and notify the appropriate supervisor.

Machine Identification:_____ Date:_____

Technician Signature:_____

Item	Condition	Comments
1. Disable the guarded machine. Apply power to the OS32C system.	Pass Fail	
2. Verify that the guarded machine is suitable for use with the OS32C system. See “Introduction” for more information	Pass Fail	
3. Visually inspect the machine to ensure that all access to the danger point is through the OS32C safety zone. If access to any danger point is possible without being detected by OS32C, additional protective measures must be taken such as barriers. Verify that all other guarding devices and barriers are installed and operating properly.	Pass Fail	
4. Verify that the maximum safety zone distance of the OS32C system is equal to or greater than the calculated safety zone distance from the danger point. Make sure that the operator cannot stand between the safety zone and the danger zone. See Chapter 4 for calculation of the safety distance.	Pass Fail	
5. Verify that the scanner can only be reset from a position outside and with a view of the monitoring zone.	Pass Fail	
6. Check for signs of external damage to the OS32C system, the guarded machine, the electrical cables and wiring.	Pass Fail	
7. Verify that the connections between the control system of the guarded machine and the OS32C are correct.	Pass Fail	
8. Start the machine. While the machine is in motion, intrude into the safety zone with the test object. The machine should stop immediately. Move the test object inside the perimeter of the safety zone. The machine should remain stopped. Caution: Never insert the test object into the dangerous parts of the machine.	Pass Fail	
9. Verify that the machine braking system is working properly. If the machine does not stop fast enough, adjust the braking system or increase the safety zone distance.	Pass Fail	
10. Record the results of this procedure in the machine log.	Pass Fail	

Declaration of Conformity

OMRON SCIENTIFIC TECHNOLOGIES INCORPORATED

OMRON Scientific Technologies Incorporated (at 6550 Dumbarton Circle, Fremont, CA 94555-3605, U.S.A.), hereby declares that the following series manufactured products listed below conform with the relevant Essential Health and Safety Requirements (EHSRs) of the European **Machinery Directive** (2006/42/EC), with the relevant requirements of the **Low Voltage Directive** (2006/95/EC), with the essential protection requirements of the **Electromagnetic Compatibility (EMC) Directive** (2004/108/EC) and with the **RoHS Directive** (2002/95/EC) - the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Laser Scanner, OS32C Series

The OS32C Series Devices are Electro Sensitive Protective Equipment (ESPE), Active Optoelectric Protective Device responsive to Diffuse Reflections (AOPDDR), Type 3, designed to detect persons as part of a safety related system.

The OS32C Series products have been type-examined per

EC Type-Examination Certificate

issued by notified body TUV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin/Germany, Certification Body for Machinery (NB No. 0035).

The following Standards were used to form the basis for the requirements and tests:

EN 61496-1:2004 + A1:2008 - Safety of machinery – Electro Sensitive Protective Equipment, Part 1: General requirements and tests.

IEC 61496-3:2008 - Safety of machinery – Electro Sensitive Protective Equipment, Part 3: Particular requirements for Active Optoelectric Protective Device responsive to Diffuse Reflections (AOPDDR).

EN ISO 13849-1:2008 - Safety of machinery – Safety-related parts of control systems, Part 1: General principle for design.

IEC 61508, Parts 1 – 7:1998 – 2000 - Functional Safety Of Electrical/Electronic/Programmable electronic Safety-Related Systems.

EN 62061:2005 – Safety of machinery. Functional safety of safety-related electrical, electronic and programmable electronic control systems.

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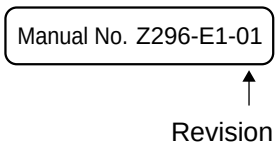
A manual revision code appears as a suffix to the manual number at the bottom of the front and back covers of this manual.



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